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LABORATORY STUDIES IN EDUCATIONAL PSYCHOLOGY

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PREFACE

This book is intended to serve as a laboratory manual for introductory courses in educational psychology. The exercises and experiments are presented in untechnical terms so that the student, as Professor Woodworth remarks,[1] "can then be set to observing for himself, instead of depending on books. Many of the facts of psychology are so accessible at least in a rough form, as to make the subject a good one for appealing to the spirit of independence in the student. Some teachers are, in fact, accustomed to introduce each part of the subject by exercises, introspective or other, designed to bring the salient facts home to the student in a direct way, before he has become inoculated with the doctrine of the authorities. 'The essential point is that the student be led to observe his own experience, to record his observation accurately—in a word, to psychologize; and to make the observation before, not after, discovering from book or from lecture what answers are expected to these questions. Individual experiments should so far as possible be performed in like manner before the class discussion of typical results. In all cases the results of these introspections should be recorded in writing, representative records should be read and commented on in class; and the discussion based on them should form the starting point for textbook study and for lecture.' "

The term *laboratory* should not be taken merely to indicate a room fitted with apparatus but should suggest a method of study, a form of thinking. The process of

[1] In Paul Klapper, *College Teaching* (Copyright, 1920, World Book Company, Yonkers-on-Hudson, N. Y.).

thinking is initiated when there is a conflict in experience, that is, when old knowledge is inadequate to meet a new situation. It is the aim of this manual to present to the student situations which will cause "thinking." Therefore, wherever "thinking" can take place, that place may be considered the proper environment for a laboratory study in educational psychology. The studies outlined in this manual will cause the student to carry on his investigations in the classroom as well as outside of it.

Laboratory work can be performed most intelligently when it occurs at the points in the course where it is needed. The practice of setting apart a definite day each week for laboratory work tends to disregard the fact that portions of a course in psychology may require many consecutive laboratory hours, whereas other portions need to be interrupted only occasionally by short laboratory exercises. In planning this manual the authors have presented a greater number of experiments than can be performed within the limits of an introductory course. The instructor, it is hoped, will, therefore, find it possible to select those experiments which meet the needs of his students and the textbook which he may be using. The performance of many of the experiments will require several hours, whereas others can be completed within the hour, or started in class and completed at home.

In general, three types of experiments and exercises are included in the manual: (1) experiments that involve elements of discovery; (2) experiments that make for verification of lecture or textbook data; (3) exercises that tend to train the student in necessary technic. Many of the experiments and exercises partake of all these three types; few are characterized by only one type.

The experiments that require the student to develop his own notions of psychology particularly appeal to the spirit of independence and the initiative of the student. This

type of experiment is the highest, but with elementary students such experiments have their limitations.

Many educators condemn the use of laboratory exercises that only make for verification of data on the grounds that such exercises thwart the spirit of independence and that, after all, few students question authority; the majority force their conclusions to agree with those of the teacher or textbook. However, in the first type of experiment the student is, as Professor Dewey remarks, playing with loaded dice, since the phenomenon he is to study has been so arranged that he can force it and thereby develop for himself principles which science needed generations to discover. Verification is an inferior aim for an experiment in that it consists of telling the student that a certain thing is true and then orders him to see that it true. If, however, verification as a laboratory aim should be dropped out, the student would be forced to rely solely upon the instructor or textbook for a discussion of many psychological phenomena, which, with his limited training, he could not possibly discover for himself. Verification through experiment supplants hazy ideas and mere words with concrete knowledge of the phenomena being studied.

As to the exercises that attempt to give the student some particular technic, little need be said. Each student cannot be left to develop his own visual or auditory tests; the risks and dangers are too many.

The order in which the experiments are presented in the manual need not be followed. In those cases where experiments are necessary prerequisites for others, notation is made to that effect. The manual has been planned to supplement *The Mind and Its Education,* by George Herbert Betts, but it is hoped that it will be of value to instructors using other textbooks and also to those teaching general psychology. With few exceptions the equipment necessary for the experiments is easily secured or con-

structed; where special equipment is necessary, the place where it can be secured is given.

Each student should possess a notebook, preferably a looseleaf book containing interquartile paper. Recording of observations, inferences, and generalizations is essential but should be secondary to experimentation. The notebook should not be made a fetish, because if too great an emphasis is placed upon the notebook as an index of the student's knowledge of the subject, the keeping of the notebook may defeat the aim of the various experiments and, in fact, become a breeder of dishonesty and superficial work.

The questions and problems which follow the experiments are designed to aid the student in summarizing the main points of the experiment and in applying the principles developed by the experiment to general and especially to educational problems. All these questions need not be answered. The instructor may find it advisable to omit some of the questions and substitute questions of his own.

The first three experiments are planned to familiarize the students with the elementary methods of studying psychological problems. In the performance of these experiments the students will probably need the aid of the instructor. Several experiments are not directly applicable to educational problems; these have been included in order to provide the instructor who teaches general and educational psychology with the necessary material.

In the experiments where the scores of the performances of individual members of the class are secured, the interest and attention of the class can be increased by the keeping of a posted list of the class names with scores. It is advisable, however, to have the class decide for themselves whether or not they desire such a record posted. With the exception of the ratings in intelligence tests, the students are not likely to object.

The students are urged not to read ahead in the experi-

ments, but to follow all directions explicitly; otherwise some of the experiments are likely to be invalidated because of familiarity with the material and the problems to be solved.

Thanks are due to the authors and publishers for the privilege of using the quoted material, and acknowledgment is given to the many sources in general from whom the authors have drawn; also to Dr. Frederic A. Woll, Associate Professor of Hygiene, College of the City of New York, and member of the New York State Board of Examination in Optometry, for his assistance in the writing of the experiment upon visual defects, and to H. M. Turner for the typing and reading of the manuscript.

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SUPPLEMENTAL REFERENCES

References will be found at the end of the experiments to George Herbert Betts, *The Mind and Its Education,* and also other standard texts.

The following volumes are treatises dealing with experiments in general and educational psychology:

FOSTER, William S., *Experiments in Psychology.*

FREEMAN, Frank N., *Experimental Education.*

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SCHULZE, R. (translated by R. Pintner), *Experimental Psychology and Pedagogy.*

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TITCHENER, Edward B., *Experimental Psychology, A Manual of Laboratory Practice,* Vol. I, "Instructor's Manual"; Vol. II, "Instructor's Manual"; Vol. I, "Student's Manual"; Vol. II, "Student's Manual."

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LABORATORY STUDIES IN EDUCATIONAL PSYCHOLOGY

EXPERIMENT 1

Observation and Report

Object.—*To illustrate the difficulties involved in observation—the necessary basis for all sciences.*

Disputed theories should, if possible, be excluded from an elementary textbook. Suffice to say, that there is no general agreement among psychologists, functional, structural, behavioristic, or dynamic, as to the proper methods for studying psychology. But all psychologists state that psychology is a science, and all sciences involve observation. The material to be observed in psychology, however, causes a division of opinion among students of the subject. (1) We may attempt to observe our mental processes by looking in upon them, that is, by introspection. (2) We may simply observe the outward expression or behavior of an individual and neglect conscious phenomena. (3) We may (and in this study shall) combine both of these methods.

According to Professor Titchener,[1] "there are four reasons why observation should be difficult: (1) In the first place, we are all naturally careless; we like to take things easily and dislike making a sustained effort. Observation requires great care. (2) Secondly, we are all biased or prejudiced. Thus we may expect to see a certain thing, or want to see a certain thing. Under these circumstances, there is every chance of our seeing that thing when it is not there to see. (3) Thirdly, it is not until we have

[1] From Titchener, *A Primer in Psychology*, Ch. ii. Copyright by the Macmillan Co. Reprinted by permission.

had a good deal of practice in observation that we know what to look for; in our first attempts we are 'all at sea,'—just as likely to make much of the unimportant as to single out the important things. (4) And lastly, when the object of observation is a process, something that continually changes, we may be confused and baffled by the change. If the process goes on slowly, we may grow tired of observing, and so overlook some of its stages; if it goes on quickly, we may not have time to notice them all."

Material.—Watch with second hand; a picture in colors suitable for pupils of the fifth or sixth grade.

Procedure, I.—Restudy the first three difficulties experienced in observation which are described in the above quotation. Observe the picture for 90 seconds so that you will be able immediately after the study to describe the picture and enumerate the objects in it. Give attention to the color and number of similar objects, etc., in the picture.

Record your description and enumeration briefly and then answer the questions given below. Do not read these questions until you have written your description.

QUESTIONS

1. Compare your description of the picture with the picture itself. What did you omit?

2. What did you include in the description and enumeration that was not actually present? Why do you suppose you included this material?

3. Did you ascribe the correct color to the various objects? If not, why do you suppose you assigned the colors you did?

4. If possible, present the picture to one or more children. What errors do they make in observation and report?

5. (*a*) Construct questions planned to elicit the most important points about the picture and present these questions to the children after they have studied the picture. With what accuracy do they answer these questions? (*b*) If possible, present these same questions to other children and let them answer the questions as they study the picture. With what accuracy do

these children report? (*c*) Which group of children is more accurate in their observations and report? Why?

6. (*a*) Construct some questions which invite incorrect answers such as, "How many black cats [taking for granted that the cats were white] were there in the picture?" Does the ability of children to answer such questions indicate they are reliable witnesses? What do these questions indicate about the suggestibility of children? (*b*) Present the same questions to adults and see if your results are the same as for the children.

Procedure, II.—Let the instructor bring a stranger into the classroom as if to introduce him to the class. Then have the stranger depart as soon as the class looks at him with noticeable curiosity. Have the class answer the following questions in such a way that a detective could find the individual in a crowd.

QUESTIONS

1. Let each student answer the following questions and place his answers on the blackboard so that each member of the class can construct a frequency distribution for the data given.[2]

(*a*) His height was about 5 ft. 6, 5 ft. 7, etc.? (*b*) His weight was about 125 lbs., 130, 135, etc.? (*c*) The color of his eyes was blue, brown, gray? (*d*) His complexion was fair, dark? (*e*) The color of his hair was black, brown, blond, gray? (*f*) Other distinguishing physical features? (*g*) Distinguishing characteristics of dress?

2. Compare the answers of the class to these questions with those given you by your instructor. How accurate and reliable are the observations?

Procedure, III.—Reread the fourth difficulty experienced in observation, as described in the above quotation from Titchener. Listen to some music, instrumental or vocal, or recite a poem which is replete with emotional appeals. Try as you do one of these things to note the

[2] For methods of constructing a frequency distribution see pp. 190-196.

responses (interest, joy, sympathy, sadness, etc.) aroused in you.

QUESTIONS

1. What becomes of your feelings when you attempt to look in upon them? Do they tend to disappear or change in character?

2. Do you experience more difficulty in observing and describing your feelings than in observing and describing a concrete object such as a flower? If so, why?

3. What characteristics do you observe in mental states under observations? (*a*) Will they remain still or do they move? (*b*) Can they be recalled and again observed? (*c*) If so, is the recall state or process identical with the original? (See Experiment 2.)

4. What educational significance does the apparent inability to observe and report accurately hold for the teacher of geography, nature study, drawing, general science, etc.?

REFERENCES

See the references at the end of Experiment 3.

EXPERIMENT 2

INTROSPECTION

Object.—*To become acquainted with introspection, a method for studying psychology.*

To remove the difficulty of changing and interfering with a mental process when we attempt to look in upon it and examine it we ought to delay our introspection until the processes we wish to examine have passed by. "Let them run their course undisturbed: then call them back by memory and look at them. They are now dead and cannot be changed by your observation. Only take care that you do not wait too long before recalling them. If a *post mortem* examination is to be of any use, it must be made soon after death. And decay sets in among mental processes as well as in dead bodies; we may forget them entirely or they may get overrun by all sorts of other and more recent

processes so that we cannot live them over again just as they were."[1]

"It is entirely probable that one will always find his mental state a complex in which more than one" mental element is represented. "In describing his mental state one should mention *all* the elements discernible, explain their nature so far as possible, and tell the order in which they appear. Be careful not to refer back to a mental state which you are examining any element which may arise in your mind NOW, but was not in your mind THEN."[2]

Material.—A bell.

Procedure, I.—The instructor will tap a bell and request the students to *think* the sound, that is, keep the sound in consciousness, as long as possible, noting just when, in order to think the sound plainly, it has to be recalled. Have the class practice this until they become able to detect the moment the experience passes over into the past.

QUESTION

1. By the aid of introspection report the mental processes involved in this exercise.

Procedure, II.—Read and perform at once the problem given below. Immediately after the completion of the problem recall by memory the mental processes involved in the solution, that is, the way in which you solved the problem. Describe these mental processes.

PROBLEM.—Take 26 and 32 and mentally multiply them. Do this with your eyes shut, do not refer to the numbers again.

Do not answer the following questions until you have described the mental processes involved in solving the above problem. These questions, if answered first, might

[1] From Titchener, *A Primer in Psychology*, Ch. ii. Copyright by the Macmillan Co. Reprinted by permission.

[2] Betts, *The Distribution and Function of Mental Imagery*, p. 52.

prejudice your responses or cause you, in solving the problem, to use the methods suggested by these questions.

QUESTIONS

1. (*a*) In solving the problem did you mentally see the 26 and 32 and then work out the problem mentally, picturing each step as if you were doing it on paper? (*b*) Did you obtain the answer without the aid of mental pictures by multiplying 2 x 26 and then 3 x 26, then adding these two numbers, remembering to place 8 of 78 under the 5 of 52? (*c*) If you did not use either of these methods, briefly describe your own method.

2. Of what value is the practice of having a pupil who has worked out an arithmetic problem incorrectly tell how he worked out the problem or of having him work it out orally again? Is the child introspecting when he does this?

3. Draw up a list of rules and suggestions for experimental introspection.

REFERENCES

See the references at the end of Experiment 3.

EXPERIMENT 3

OBSERVATION OF OBJECTIVE BEHAVIOR

Object.—*To illustrate the observation of behavior, without reference to conscious phenomena.*

Procedure.—Present the problem you solved in the previous experiment to at least five children of the following ages (according to their last birthdays)—10, 11, 12, 13, 14, and 15. In selecting the children attempt to obtain children of 10 years of age who are in the fourth grade, of 11 years of age who are in the fifth grade, etc.; that is, children who are in the proper grade for their chronological age. Allow no more than one minute for the completion of the problem, the time is to be recorded from the moment you complete the reading of the problem to the

child. The problem is to be considered as failed if incorrectly answered or if not answered within one minute.

Tabulate the responses you have obtained, and also the results obtained by five of your classmates, in a table as follows:

Name of Experimenter	*Ages of Children*					
	10 Years		*11 Years*		*12 Years*	
	Passed	Failed	Passed	Failed	Passed	Failed
1						
2						
3						
4						
5						
6						
Total						

Questions

1. Make interpretations, based upon the objective data, as to the abilities of the pupils of different ages to solve this problem.
2. Compare the relative values of the two methods for studying psychology illustrated in this and the previous experiment.
3. Would you suggest the elimination of either method? Give the reasons for your answer.
4. A certain physician says that he always asks his patients to describe how they feel, but that he depends much more on his own observation of symptoms. How does this illustration relate to the two methods just referred to?

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Averill, L. A., *Elements of Educational Psychology*, pp. 164-169.
Starch, Daniel, *Educational Psychology*, pp. 132-138.
Titchener, E. B., *A Primer in Psychology*, Ch. ii.
Whipple, G., *Manual of Mental and Physical Tests*, Part II, pp. 9-42.

EXPERIMENT 4

The Mind or Consciousness

Object.—*To become better acquainted with the general nature and content of consciousness by verifying, through introspection, the textbook discussion of the subject.*

It has been stated that, "in looking in upon the mind we must expect to discover, then, not a *thing*, but a *process*. The *thing* forever eludes us, but the process is always present. Consciousness is like a stream, . . .

"A stream is an unbroken whole from its source to its mouth, and an observer stationed at one point cannot see all of it at once. He sees but one little section which happens to be passing his station point at that time. . . . When we turn about quickly and look in upon our minds, we see but the little present moment.

"We should at one time find the mind manifesting itself in *perceiving, remembering, imagining, discriminating, comparing, judging, reasoning,* or the acts by which we gain our knowledge; at another in *fearing, loving, hating, sorrowing, enjoying,* or the acts of feeling; at still another in *choosing,* or the act of the will. These processes would make up the stream, or, in other words, these are the acts which the mind performs in doing its work."[1]

Procedure, I.—Select some recent event, such as your attempt to answer a question in class. Recall this event and as completely as possible write an account of it, giving attention not only to the stimuli (the question itself, attitude of the teacher and class, quietness of room, etc.), and your answer, but also to all your responses (bodily reactions, mental states, etc.).

Place your account on a sheet of paper, leaving at the

[1] Betts, *The Mind and Its Education,* Ch. i.

right a margin of 2½ inches. In this margin analyze the mental states portrayed in your account by using your own descriptive terms and also those found in the textbook which you are using. In order to indicate the particular processes evident, place these terms directly opposite the part of your account which they attempt to describe.

QUESTIONS

1. Does the mind at any one moment give evidence of only one process, such as reasoning? Justify your answer on the basis of your own experiment.
2. Give an account of the general nature and content of consciousness based upon your own findings.
3. Give an original example taken from the performance of some elementary school task, showing that feeling, knowing, and willing are connected.

Procedure, II.—Let the instructor construct a problem in arithmetic and have it mimeographed so that each student can be supplied with one copy. Present the problem in the following manner: "I am going to have placed on your desks, with the mimeographed side down, a problem in arithmetic. When I say 'Ready!' you are to take your pencil and be prepared to turn over the paper and begin work when I say 'Go!'—Ready! [allow an interval of 10 seconds] Go!"

QUESTION

1. Compare the mental state of expectancy with the mental state of problem-solving as evidenced in the experiment just described. Are the same mental states present? In what degree are the states present?

REFERENCES

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COLVIN and BAGLEY, *Human Behavior*, Ch. i.
CAMERON, E. H., *Psychology and the School*, Ch. i.
LA RUE, D. W., *Psychology for Teachers*, Chs. i, ii.
COLVIN, S. S., *The Learning Process*, Ch. i, especially pp. 1-8.
WOODWORTH, R. S., *Psychology, a Study of Mental Life*, Ch. i.

EXPERIMENT 5

DURATION OF ATTENTION

Object.—*To determine the duration and the more important characteristics of attention.*

It is advisable that the experiments upon attention be performed before the students read the textbook. The performance of these experiments will enable the student to formulate his own interpretation of the nature and types of attention and also to comprehend more completely the textbook discussion of the subject.

Material.—Watch or clock.

Procedure, I.—Place a dot, about the size of a lead-pencil point, upon the center of a plain piece of white paper, 8 inches square. Place this paper vertically against a support at a distance of 2 feet from the eyes. With the head and eyes as steady as possible attempt to look at this dot for at least 3 minutes.

Procedure, II.—Place yourself in a quiet room so that you can just hear the ticking of a clock or watch. With your head in the same position throughout the experiment attempt to listen to this ticking for at least 3 minutes.

QUESTIONS

1. Can you attend for any length of time to either of the stimuli, that is, the dot or the ticking of the clock?
2. Does the apparent magnitude of the stimuli change as you try to attend to them? If so, describe the change.

3. What are the chief differences involved in your attention to these simple stimuli and to an associated group of stimuli such as a picture, a musical composition, or a passage in a book?

4. Is it possible to attend to one single object for many minutes at a time? If not, why?

5. What are some of the reasons for allotting only four or five minutes to drill in the fundamentals of arithmetic? Why are pupils able to attend to arithmetic problems for fifteen or more minutes?

6. Pupils' misbehavior in school often starts with innocent and justifiable inattention to the subject being presented. What partial solution to the problem of inattention does this experiment offer to the teacher?

7. Why is it advisable in the case of young pupils to make lessons short and to introduce a variety of illustrations and methods of treatment?

Procedure, III.[1]—Let the members of the class visit an elementary-school classroom. Let each student select one pupil to observe and make careful notes for five minutes of all evidences of changes of attention. Utilizing the information gained from the performance of the experiments in I and II answer the following questions.

QUESTIONS

1. How long did attention seem to rest on one topic without change? Upon what do you base your judgment?

2. Is it possible to give the impression of being attentive to one thing (as keeping the eyes on the book; or looking the instructor in the eye as if listening), when the mind is far afield?

REFERENCES

See references at the end of Experiment 7.

[1] Experiment 7 may be performed at the same time.

EXPERIMENT 6

Expectant Attention

Object.—*To show that familiarity with an object tends to increase the degree of attention given to it.*

Material.—Watch; measuring tape.

Procedure, I.—This experiment is to be performed by two students—one to act as the Experimenter, the other to act as the Subject. The Subject should not be familiar with the general nature of this experiment until its completion.

The Experimenter should have the Subject sit in a quiet room and have him close his eyes. He should then hold a watch straight out at a distance of 10 or more feet from the Subject's right ear. Hold the face of the watch at all times toward the Subject. Tell him to say, "Stop," when he first hears the ticking of the watch. Gradually approach in the direction of the right ear until he hears the ticking. Measure the distance from the leg of the chair to the point at which he first hears the ticking. Repeat the above procedure two more times, and be certain to advance along the same line with the face of the watch towards the Subject, held in exactly the same position for all three trials. Add the distances secured and divide by 3; you will then have the mean (average) distance at which he just hears the ticking of the watch.

Let the Subject now become familiar with the ticking of the watch by allowing him to hold it to his ear for several seconds. Then reënact the above experiment, following all the conditions described above. Keep your record of the mean distance at which he now hears the ticking of the watch.

Procedure, II.—This experiment is similar to **I,** except hat the stimulus is now visual instead of auditory. Keep he Subject and the Experimenter the same. Take three heets of plain white paper about 8 inches square. On each f these papers print lightly with a hard lead pencil a dif-ɔrent word of six letters. Place the word near the center f the paper and make the letters about ¼ inch high. 'lace one of the sheets of paper on the wall opposite the ne from which the Subject is to walk. Tell the Subject ɔ approach the paper and stop the moment he is able to ɔad the word. Record the distance from the paper at 'hich he recognizes the word. Do this in similar manner ɔr the other two words. Secure the mean distance for ıe three measures.

Let the Subject now see each sheet at close range and nmediately after seeing the word perform the experiment s described above for the three words. Secure the mean istance at which he now recognizes the word.

Questions

1. Compare the mean distances at which the relatively un-amiliar auditory stimulus was heard with the mean distance at 'hich the familiar auditory stimulus was heard. Also make this ɔmparison for the visual stimuli.

2. How do you account for the above differences in ability to iscern the various stimuli?

3. In a drawing lesson the teacher called upon the pupils to escribe the basket and the ball of thread which were to be rawn. After the important points, the position of the basket's andle, etc., were described, the pupils were required to draw ıe objects. What was the value of the word descriptions?

4. In assigning home work in grammar one teacher simply ssigned the pages in the textbook to be studied and another ɛacher called the pupils' attention to the topics to be studied, the urpose of the assignment, etc. Which practice would you fol-ɔw? Why?

5. Probably not less than one child out of ten in the lower grades has a defect of vision such that it makes it impossible for him to read easily from the blackboard at usual distances. What bearing on the pupils' inability to read dimly seen script has the fact that much of the matter on the blackboard is new and unfamiliar?

6. Formulate a general rule about attention based on this experiment.

REFERENCES

See references at the end of Experiment 7.

EXPERIMENT 7

TYPES OF ATTENTION

Object.—*To analyze and classify the various kinds of attention.*

Our native equipment, that is, our unlearned behavior, often determines that we attend to particular objects. This sort of attention is frequently characterized as *passive attention* because it requires little or no effort upon our part and occurs in us apart from learning. We naturally attend to loud noises, moving and highly colored objects. In contrast to passive attention we have *active attention,* which requires effort and perseverance on our part before we can bring ourselves to attend to the situation. Frequently, active attention, because of the development of habits, and the recognizance of the necessity for attending, becomes somewhat easier, requiring less effort and perseverance. Such attention is called *secondary-passive attention.*

Every teacher meets the problem of appealing to passive attention in order to change active into secondary-passive attention.

"It is not to be understood, however, from what has been said that there are *really* different kinds of attention. . . . The difference is rather *in the way in which we secure attention;* whether it is demanded by sudden stimulus, coaxed from us by interesting objects of thought without effort on our part, or compelled by

force of will to desert the more interesting and take the direction which we dictate."[1]

Procedure.—Visit an elementary-school class, preferably a kindergarten class. Select one particular child, and, without this child's knowledge, observe and record in your notebook the various objects and situations calling for his attention. Note the shifting character of his attention and the situations that cause these shifts of attention. With your watch, note the length of time attention continues on the object.

In the quiet of your study attempt to classify the various kinds of attention evident. You will, of course, experience difficulty in your classifications because, as stated above, there are not really clear-cut kinds of attention since the so-called kinds shade one into the other. Place your account of the child's actions on a sheet of paper, leaving at the right a margin of 2½ inches. In this margin place your analysis of the types of attention present.

Questions

1. Briefly compare and indicate the differences evident in the so-called kinds of attention.
2. Show that attention is an essential factor of all mental states.
3. How may a teacher utilize passive attention in order to change active to secondary-passive attention? Give illustrations.
4. Of what value is the use of games in teaching school subjects? Illustrate how spelling and some phase of grammar can be taught through games.
5. History, civics, and literature are often taught through dramatization. Why?
6. Of what psychological value is the practice of praising pupils' work, and giving stars for good work?
7. It is common experience that one is more interested in and

[1] Betts, *The Mind and Its Education*, Ch. ii.

attends with less effort to a subject or study about which he already knows something. What bearing has this fact on the effort that should be used to make the introduction to new subjects interesting to children?

8. Write on the blackboard before a group of elementary school pupils a list of all their subjects, having each pupil copy the list on a sheet of paper. Then ask them to rewrite the list putting at the top of the column the study they like best; second, the one they like next best; and so on, finally putting last the one they like least. Then observe the class at work on each of these subjects and note whether attention follows the attractiveness of the subject.

9. If you noticed a class you were teaching losing interest and becoming listless, what causes might you suppose to be at work? What procedure would you adopt to eliminate this situation?

10. On the basis of Experiments 5, 6, and 7, briefly give in your own words an account of the meaning and general characteristics of attention.

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Seashore, C. E., *Introduction to Psychology*, Ch. xix.

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EXPERIMENT 8

Habit Formation[1]

Object.—*To formulate the rules of habit formation.*

Material.—Watch with second hand; mirror;[2] coördinate paper.

Procedure.—The experiment is to be performed by two students, one to act as Experimenter and the other as Subject. If an ordinary mirror is used, the Experimenter should see that it is held vertically and steady so that the Subject can see the reflection of his own hand and a sheet of writing paper. To prevent the Subject from seeing directly the paper and the word which he is tracing, the Experimenter should hold a piece of cardboard just over the hand of the Subject.

Print such a word as "STOP" on ten pieces of paper, making the letters about ½ inch high, and, as nearly as possible, make each word of uniform size and quality. Number these papers from 1 to 10 and use them in this order.[3] Arrange the first paper so that the reflection of the word can be seen in the mirror. Let the Subject place the point of his pencil on the first letter of the word which is to be traced. Now let the Subject trace the word by looking in the mirror in order to guide his hand. When the Subject begins to trace, note the position of the second hand of the watch, and record on the sheet of paper the time necessary to complete the tracing. Repeat this experiment with the other nine sheets of paper. Urge the

[1] It is advisable that this experiment be performed before the students read the textbook.

[2] C. H. Stoelting Co., Chicago, Ill., supply a special mirror for this experiment.

[3] To habituate the act completely, more than ten repetitions would be necessary.

Subject throughout the experiment to do his best. Let the Experimenter now act as Subject and repeat the experiment.

Arrange the sheets in order of quality and letter them from *A* to *J*. If you are in doubt as to the relative quality of any two sheets, arbitrarily assign the higher quality to the one which required less time to complete. Each sheet now has three facts upon it: (1) a number, indicating the order in which the sheet was presented to the subject; (2) the time in seconds, indicating the time necessary to complete the tracing; and (3) letters from *A* to *J*, indicating the relative quality of each tracing.

Questions

1. Graphically represent the improvement evident:[4] (*a*) in the time necessary to complete the tracing, by letting the *x*-axis represent the order in which the sheets were presented to the subject and the *y*-axis represent the time necessary to complete the tracing; (*b*) in the quality, by letting the *x*-axis represent the order in which the sheets were presented to the subject and the *y*-axis the increase in quality. Remember that the shortest time represents the best, and that the best quality is *A*, etc.

2. Formulate a set of rules for habit formation. After you have formulated your rules, compare them with those given by your textbook.

3. Do you believe that the rules applying to motor habits (such as covered by the above experiment) also apply to moral and intellectual habits? Why?

4. What relationship does habit formation bear to learning? (We may, at present, understand that learning is the modification of behavior through experience.)

5. Why is it advisable to catalogue the common errors made in oral English by pupils and then assign definite ones to each grade for correction and drill, rather than expect each teacher to be responsible for all errors? Answer this question in the light of habit formation.

[4] For methods of constructing graphs see pp. 196-199.

6. Comment upon the statement: In inculcating habits the teacher should, where possible, make the pupils feel the need and value of the habit. Show how you would do this in teaching the correct position of the arm and fingers in writing.

7. A high-school girl in working a problem in algebra was observed to be performing addition by counting on her fingers. Account for this, from the standpoint of habit. Make a list of practices sometimes followed in the schoolroom which lead to undesirable habits.

8. A young teacher, wanting to impress her class with the correct spelling of the word *separate,* said, "Never write it this way [writing on the blackboard], *s-e-p-e-r-a-t-e;* write it this way, *s-e-p-a-r-a-t-e.*" Criticize her method from the point of view of habit formation. It has been said that "if we could save the *first* misspelling of a word, it would never be misspelled." Show that this seemingly foolish statement has a good basis in laws of habit forming.

9. Show that the correction of any wrong method of performing an act, as of writing on a typewriter, pronouncing a word, playing a game, requires the breaking up of one system of habits and the forming of another system in its place.

10. In the light of your study of habit formation, what measures would you take to secure honesty and thoroughness in school work?

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EXPERIMENT 9

Cutaneous Sensation

Object.—*To investigate and determine the number and general nature of cutaneous sensations.*

"In actual experience sensations are never known apart from the objects to which they belong. This is to say that when we see *yellow* or *red* it is always in connection with some surface, or object; when we taste *sour,* this quality belongs to some substance, and so on with all the senses. Yet by sensation we mean only *the simple qualities of objects known in consciousness as the results of appropriate stimuli applied to end-organs.* We shall later see by perception these qualities fuse or combine to form objects, but in the present chapter we shall be concerned with the qualities only. Sensations are, then, the simplest and most elementary knowledge we may get from the physical world,—the red, the blue, the bitter, the cold, the fragrant, and whatever other qualities may belong to the external world."[1]

Material.—Needle; toothpick; long wire nail; cork; ice; matches; four different colored inks; two pieces of transparent paper 2 inches square. Drive the nail through the cork so that the cork will serve as a handle for the nail when the nail is heated or cooled.

Procedure.—The experiment is to be performed by two students, one acting as the Experimenter, the other as the Subject. Let the Experimenter mark with ink an area ½ inch square on the under surface of the Subject's arm. Select a spot free from hair (or remove the hair, if necessary) midway between the elbow and wrist. Blindfold the Subject throughout the entire experiment.

I. Let the Experimenter explore the marked-off area with the point of the needle, sufficiently hard, but not hard

[1] Betts, *The Mind and Its Education,* Ch. vi.

enough to pierce the skin, to cause the Subject to experience pain. At the particular spots where the Subject is certain he feels pain, mark that point with one of the inks. Continue to explore the surface carefully, but without dragging the needle, and locate as many *pain-spots* as you can.

II. In a similar manner explore the same skin surface with a toothpick, by touching the surface of the skin lightly. Mark with a different colored ink all of the spots which the Subject recognizes as just being touched, that is, the *touch-spots*. Warn the Subject to note only the touch-spots and nothing else.

III. Place the wire nail in ice water. Dry the point and quickly apply it to the surface of the skin, and mark with still a different colored ink all of the spots as reported by the Subject as being sensitive to the cold, that is, the *cold-spots*. Be certain that the nail is always cold.

IV. Warm the end of the nail; test it on your own hand in order to make certain that it is not too hot. Apply it to the surface of the Subject's skin and mark with still a different colored ink all of the spots reported by the Subject as being sensitive to warmth, that is, the *warm-spots*. Be certain that the nail is always warm.

Questions

1. Place a piece of transparent paper over the marked-off area and with the appropriate colored ink trace the various pain, touch, cold, and warm spots. Make another copy of this record so that the Experimenter and Subject will each have one. Paste these records in your notebook and indicate what spots the different colored inks represent.

2. Was it possible to stimulate the same spot with the four different stimuli? If necessary, experiment further in order to answer this question.

3. Count the various spots for each sensation discovered. Which sensation has the greatest number of spots? Which

next? Etc. Compare your results with the findings of several other members of your class.

4. Were there any places on the skin, within the area marked off, not susceptible to any of the stimulations used?

5. Give an account in your own words of the cutaneous sensations.

6. To what extent do you think practice in observation of such sensory experiences improves your discrimination of them.

7. Having in mind the experiments upon attention, account for the fact that one may receive a considerable injury in a game without having noticed it; or may become so interested in the reading of a story as not to hear a perfectly audible call.

REFERENCES

See references at the end of Experiment 10.

EXPERIMENT 10

KINÆSTHETIC SENSATIONS

Object.—*To study the general nature and function of kinæsthetic sensations.*

The muscles, tendons, and joints give rise to sensations which, however, have not been definitely named as have been the sensations from most of the other end-organs. The sensations from the muscles are usually designated as *muscular* sensations, those from the tendons as *strain* sensations, and those from the joints as *articular* sensations. These sensations are important because without them accurate movement, such as writing, throwing a ball, etc., would be impossible. Of course, such movements as involved in writing are complex and involve visual, tactual, and other sensations as well as kinæsthetic sensations, the term used to designate the muscular, strain, and articular sensations.

Procedure, I.—With your eyes closed extend your right arm directly in front of you and then swing it to the right just as far as you possibly can.

II. With your eyes closed stand squarely upon both

feet and twist your trunk to the right, at the same time holding your head to the front.

QUESTIONS

1. Try to discover where the sense-organs affected by the above exercises are located.

2. What sensations, in addition to the cutaneous sensations, seem to be aroused? Describe these sensations.

3. How are you, with your eyes closed, able to locate definitely the position of your arm, head and trunk? (In your answer to this question be certain that you allow for the cutaneous sensations which are also present.)

III. With your eyes closed extend both of your arms forward with palms turned upward. Let a classmate place in each palm two objects, one at least twice the weight of the other.

QUESTIONS

1. How, in part, do you seem to distinguish the difference in weight between these two objects?

2. Give an experience in judging relative weights where vision has tended to bias and influence your judgment.

IV. With your eyes closed write your name and home address.

QUESTIONS

1. To what extent is your writing due to the kinæsthetic sensations?

2. Why is it necessary for some people to write a word before they know whether they are spelling it correctly?

V. Shut your eyes and let your right arm and fingers relax upon the table. Let a classmate move your hand so that you write a short sentence.

QUESTION

1. What did you write? In what way does the above "writing" differ from the writing you did in **IV** and in ordinary writing?

General Questions

1. Describe the kinæsthetic sensations, indicating the apparent function of each.

2. Are other sensations usually present when the kinæsthetic sensations function? If so, give illustrative cases.

3. In the light of the experiment comment upon the quotation: "The practiced writer can write about as well with his eyes closed as with them open. The chief difference is in such features as alinement, spacing and heaviness of stroke." (Starch.)

4. Select two of the following activities and indicate the part played in them by the kinæsthetic sensations: shop work, sewing, clay-modeling, paper cutting, cooking, etc.

5. Explain the part played by the kinæsthetic sensations in the "touch system" of typewriting. Mention other phases of school work in which kinæsthetic sensations play an important part.

References

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EXPERIMENT 11

Visual Defects

Object.—*To learn the simple methods of detecting the common visual defects.*

Part I

The teacher and the educational psychologist need to know how to determine the existence of sensory defects, particularly of the eyes and ears—the two most important avenues for obtaining information. The external stimulus has little effect if the

sense organs do not respond. For the present, we are concerned with the visual defects.

In the normal eye parallel rays of light are focused directly upon the retina when the eye is at rest; that is, the refraction of the eye is normal and the retinal image is perfect. This condition is known as emmetropia.

The most common visual defects are due to some form of ametropia, that is, a defect in the shape of the eyeball, lens, or cornea which causes errors in refraction and hence a defect in the formation of the retinal image. The forms of ametropia are: myopia, hyperopia, and astigmatism. Myopia, or short-sightedness, is commonly produced by too long an eyeball, so that the rays of light coming from an object beyond a certain distance are focused in front of the retina, hence when the rays finally impinge upon the retina a blurred image results. Myopia, in itself, usually causes no eye strain, but there is an effort of the muscles of the forehead and eyelids, thus causing strain and headaches. Unless discovered and checked by properly fitted concave lenses (which should be worn constantly) and also supplemented by cautious use of the eyes (that is, holding book and work at a proper distance from the eyes, etc.), myopia may increase in degree and with other complications result in blindness. Myopia may be found with other defects such as astigmatism.

Hyperopia, or far-sightedness, is commonly produced by too short an eyeball, so that the rays of light are intercepted too soon, thus being prevented from being brought to a normal focus; that is, the image would be formed at a point back of the retina if the rays of light were extended. The strain upon the muscles which attempt to accommodate the crystalline lenses in order to form as clear an image upon the retina as possible, is severe, especially for near objects. Hyperopia is frequently accompanied by one or more of the following symptoms: frontal or occipital headache; inflammation of the eyes, lids, or conjunctiva; and often a twitching pain within the eyeball. Students suffering from hyperopia may hold their work at some distance from the eyes, but in very severe cases, in order to increase the size of the image, they often hold the book near the eyes, thus

giving the appearance of myopia. Properly fitted convex lenses (which should be worn constantly) tend to correct, but do not cure, the errors of refraction causing this condition.

Astigmatism is due to the fact that the curvature of the cornea, or, less commonly, the lens, is not the same in all directions. The rays of light from some parts of the field of vision, due to the uneven radius of the curvature, may be focused either in front of the retina as in myopic astigmatism or intercepted too soon and therefore would, if they were extended, be focused at a point back of the retina, as in hyperopic astigmatism. Astigmatism may also be the result of a combination of these two conditions. Due to this condition one portion of the field of vision will be blurred while another will be clear and distinct. The surface of the cornea is normally spherical in form, but in astigmatism the cornea is curved more in one axis, or meridian, than in another. In correcting the errors of refraction due to this condition (it cannot be cured), a cylindrical lens of the proper curvature must be so placed before the eye that it is at the proper axis to counteract the improper refraction. More than one-half of the headaches are considered to be caused by astigmatism. Astigmatism exists in a mild form in practically all people, and is often complicated with other visual defects. In fact, the various forms of ametropia commonly appear in combinations and also commonly are unlike in the two eyes of the same individual.

We have omitted from our discussion presbyopia, far-sightedness of old age, which, strictly speaking, is not a form of ametropia but is an anomaly of accommodation appearing in most people after the age of forty.

Material.[1]—Lowell's test type (for literates); Seitz's test cards (for children).

Procedure.—The following technic of testing the eyes is to be practiced by the students in pairs. Each student is to act both as Subject and Examiner in all of the particulars described.

[1] Can be obtained from C. H. Stoelting & Co., Chicago, Ill.

Lowell's test type (a modification of the Snellen chart), is to be used first. Make certain that you obtain the following conditions before you begin the testing:

1. Since the intensity of daylight varies considerably at different hours of the day, artificial light should be used. The direct rays of the sun should not be used. Select the best position for the light in the room. Make certain that the card is well illuminated with strong, even, artificial light which should be shaded carefully so that it does not shine in the direction of the Subject.
2. The card is to be placed vertically on the wall so that it is on the level with the Subject's eyes.
3. The Subject is to stand during the testing.
4. Draw a chalk mark on the floor exactly below the place where the card is to be placed, and mark this point 0; measure from this point 2 feet, make a line and mark it 2; from this 2-foot mark measure 2 feet more, make a line and mark it 4; continue marking off 2 feet until 20 feet have been marked off.

The eyes of normal acuity [2] can see the letters, designated as 20-foot letters on the Lowell chart at a distance of 20 feet. Therefore have the Subject stand with his toes at the 20-foot mark. Place a card before the Subject's left eye. The Subject is to be instructed to keep both eyes open. Point to the 20-foot letters (do not cover or shade the letters), and request the Subject to read them aloud. Keep a record of the responses, but do not correct any error. If all but one or two of these letters are read correctly without marked hesitation or strain, record the result for the right eye as $\frac{20}{20}$, that is, $\frac{\text{distance from chart}}{\text{line read}}$; do not consider this a fraction, it is simply a convenient expression. This indicates normal acuity, that is, the Subject reads at a distance of 20 feet the size of letter read by a person of normal acuity.

[2] Normal acuity should not be confused with normal vision. This topic will be discussed below.

If, however, the Subject is unable to read the 20-foot letters, point to the 30-foot letters. If the Subject is now able to read all but one or two of these letters, his acuity is $\frac{20}{30}$, that is, he reads at a distance of 20 feet what a person with normal acuity reads at a distance of 30 feet. If the Subject cannot read these letters, point to the 40-foot letters. If he reads these letters, his acuity is $\frac{20}{40}$. If these letters cannot be read, point to the 50-foot letters. If he reads these letters, his acuity is $\frac{20}{50}$. We may represent $\frac{20}{30}$, $\frac{20}{40}$, and $\frac{20}{50}$, as $\frac{2}{3}$, $\frac{1}{2}$, and $\frac{2}{5}$, respectively.

If the Subject is unable to read the 50-foot letters, have him move up to the 18-foot mark, or to that mark at which he can read the letters. For example, if he reads the letters at the 14-foot mark, his acuity of vision is $\frac{14}{50}$.

If the Subject reads the 20-foot letters, point to the 15-foot letters and ask him to read these aloud. Continue to do this with the 10-foot letters if he was able to read the 15-foot letters. Record the acuity of vision as $\frac{20}{15}\left(\frac{4}{3}\text{, not } 1\frac{1}{3}\right)$, or $\frac{20}{10}\left(\frac{2}{1}\text{, not } 2\right)$, as the case may be.

In like manner test the left eye. If the Subject wears glasses, test his eyes with and without the glasses, noting whether the glasses correct the error of refraction, if such an error exists.

Now use Seitz's card, designed for children and illiterates. Make certain that the conditions set for the use of the Lowell card are fulfilled. Instead of reading letters, the Subject is now expected to be able to identify and name pictures. It may be necessary to ascertain at

close range whether the child knows the pictures before beginning the test. Apply the same general principles described above for the Lowell chart to the 20-foot pictures, etc.

On the basis of the testing so far conducted it is only possible to speak accurately of the acuity of vision. When the acuity of vision is $\frac{20}{20}$, we may *assume* one of two conditions: (1) the subject is emmetropic (free from myopia, hyperopia, and astigmatism), or (2) he is free from myopia, but has hyperopia or astigmatism. When the acuity of vision is less than $\frac{20}{20}$, the indications are that an ametropic condition is present which may be myopia, hyperopia, astigmatism, or any combination of these conditions. When the vision is greater than $\frac{20}{20}$, hyperopia probably is present.

Since it is the duty of the lay teacher to select those pupils who need to be examined by the oculist, or optometrist, it is not necessary for him to attempt to diagnose the condition. Many elementary treatises make a serious error in giving the layman the idea that the diagnoses of eye defects are relatively simple. Such treatises recommend the use of the concave lens (—.75 D.S.), and the convex lens (+.75 D.S.), stating: (1) if the concave lens improves the acuity of vision, the Subject is probably myopic; (2) if the concave lens has no effect whatsoever upon the acuity of vision of less than $\frac{20}{20}$, amblyopia[3] is present; (3) if in the case of an acuity of $\frac{20}{20}$ or greater, the convex lens blurs the letters, the eye is emmetropic, but if the

[3] Amblyopia is a reduction in the acuteness of vision which is due to a defective sensibility of the retina and which cannot be relieved by glasses.

Subject is able to read the letters, or smaller ones, the eye is hyperopic. These statements may or may not be true; only the trained oculist or optometrist can decide.

The hyperopic eye has to make an accommodative effort for distant vision, and a still greater effort for near vision, but a myopic eye does not make such an accommodative effort for distant vision and makes little or no effort for near vision. In emmetropia there is no accommodative effort for distant objects (that is, the eye is at rest), but for near objects there is an accommodative effort. 6629

Since in hyperopia the eye must accommodate for distant objects and especially for near objects, the eye strain is great. Furthermore, this accommodation tends to hide the hyperopic condition which is, therefore, very difficult to diagnose. The strong powers of accommodation possessed by young children makes the use of lenses in the hands of the layman of doubtful value, especially when confined to a $-.75$ D.S. lens and a $+.75$ D.S. lens. In myopia there is no accommodative effort of the ciliary muscle for distant vision, but in an effort to see, the myopia contracts the muscles of the forehead and eyelids (sometimes called squinting) thus causing strain and headaches, but this condition may not necessarily be regarded as eye strain. It will be seen from what has been said that the hyperopic eye must work all the time with no rest, and perhaps overdevelop the ciliary muscle, whereas in the myopic eye, since there is small necessity for the muscles of accommodation to work, a consequent underdevelopment of the ciliary muscle results. Therefore, the hyperopic should constantly wear glasses in order to bring his effort down to the normal, and glasses should also be constantly worn by the myopic in order to bring the internal parts of the eye up to the normal In view of these statements the teacher should urge children who have been fitted with glasses to wear the glasses at all times in order to conserve

their sight, unless the specialist has explicitly advised to the contrary.

A test for astigmatism is of little value unless all the myopia or hyperopia that may be present is corrected. Even in cases of simple astigmatism (that is, without any myopia or hyperopia being present) the specialist has difficulty in finding the astigmatism, although he is equipped with the proper instruments and skilled to find it. Low errors of astigmatism, either myopic or hyperopic, may just as easily be covered or hidden by the eye efforts of accommodation of the young pupil as his errors of myopia or hyperopia. Therefore, it is apparent that an astigmatic chart (recommended by some treatises) in the hands of the layman is of questionable value in finding any kind of astigmatism. For these reasons a discussion of the use of an astigmatic chart is not included in this manual. As previously stated, the teacher's duty is to aid in the discovery of eye defects for the purpose of sending such pupils to the specialist and not to diagnose eye defects. An acuity of less or greater than $\frac{20}{20}$ will be indicative to him of the necessity of securing the specialist's help.

Part II

Each eye is moved by varying combinations of six muscles. The balance and innovation of these six muscles, when perfect, permit the eyes to move in a coördinated manner so that single vision exists. In some individuals the two eyes are not well coördinated. When one eye deviates, that is, when the visual lines of the two eyes are not directed toward the same object, diplopia (double images) result unless the image of the deviating eye is mentally neglected or ignored.

There are two general terms used to designate the lack of coördination of the outside muscles of the eye: (1)

heterophoria, which means a tendency of the axes of the eyes to turn away from parallelism, and (2) heterotropia, which means the actual deviation from parallelism. The most common forms of heterophoria are: (1) esophoria, a tendency of the eyes to turn in (the optic axes converge), and (2) exophoria, a tendency of the eyes to turn out (the optic axes diverge). The most common forms of heterotropia are: (1) esotropia, an actual turning in of the eyes, and (2) exotropia, an actual turning out of the eyes.[4] Both of these conditions may be due to an error of refraction in one or in both eyes or a difference in the refraction of both eyes. Therefore, if the proper glasses are worn, the actual deviation of the eyes or the tendency of the eyes to deviate will disappear. If, however, the deviation is due to an impaired muscle or muscles with or without visual defect, then prisms, exercises, or operation may be necessary, but only the specialist can tell. In strabismus the most evident symptom is disfigurement, that is, "cross eye" or "wall eye." The deviating eye usually shows a diminution of the acuity of vision. Diplopia (double images) may exist in the very early stages, but this condition soon disappears owing to the psychical process of excluding the image of the squinting eye. In the more severe cases of heterophoria headaches, pain in the eyes, various neuralgias, irritable condition of the lids, indistinctness of print, etc., are often present. In the mild cases frequently none of these symptoms are present. It is apparent from what has been said that the layman can not with any accuracy use the Maddox multiple rod or stenopaic lens which are recommended in some treatises.

The time is still distant when trained examiners will thoroughly examine all children during their school life, hence the school teacher must be prepared for this task.

[4] Esotropia and exotropia are commonly referred to as convergent strabismus and divergent strabismus respectively.

In brief, the teacher ought to be ever on the watch for evidences of impairment of vision and to send pupils with such defects to the specialist and thereby contribute to the welfare of the pupils and the conservation of eyesight.

Problems

1. Examine the eyes of at least five individuals. If you cannot obtain pupils from the elementary grades test five members of your own class, and check your findings with those who have already tested these individuals. In cases of disagreement retest the eyes. Record your findings in a tabular form, allowing for the following headings: name, acuity of vision (without glasses), right eye and left eye; acuity of vision (with glasses), right and left eye; pain as symptom of eye defect.

2. If your school system has medical inspections, look up the records of defects in vision. Nature of defects? What proportion? Educational significance?

3. If your school system does not have medical inspections, perhaps arrangements may be made for members of the class to test the vision of several grades. What proportion of pupils are found with defects of educational significance? Possibly a local oculist or physician will advise you as to the details of procedure.

4. Inquire of your friends who wear glasses whether they had been unaware of their impairment of vision before being fitted with glasses. What does this indicate about the importance of periodic eye examinations?

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EXPERIMENT 12

Color Blindness

Object.—*To become acquainted with the technic of testing for color blindness.*

The occurrence of color blindness "in from 3 to 4 per cent of males and in only 0.3 of females,"[1] makes this condition not only one of theoretical interest but also of practical importance. The pupils who confuse red and green are at a disadvantage in such school work as domestic science, nature study, and other work in which color discrimination is involved. Various occupations such as railroading, medicine, chemistry, etc., ought to be closed to color-blind persons.

The most common confusion is the inability to discriminate between red and green. Violet blindness (also known as blue-yellow blindness) almost never occurs, and in fact its existence is in much dispute. Total color blindness does exist, but it is rare and is probably due to a pathological defect. A number of theories have been proposed to explain color vision and color blindness, but no one theory so far advanced satisfactorily explains all the known facts, therefore these theories will not concern us here.

Material.—Holmgren's worsteds.[2]

Procedure.—The Holmgren worsteds consist of test colors, match colors, and confusion of colors. The test colors are a pale green, a rose, and a bright red. The match colors consist of lighter tints and darker shades of the test colors, whereas the confusion colors consist of hues that color-blind individuals usually select as matching the test colors, for example, such hues as yellow, brown, gray, drab, mauve, etc.

The test is to be made in daylight but not in the direct

[1] May, *Diseases of the Eye.*

[2] Can be obtained from C. H. Stoelting & Co., Chicago.

rays of the sun. Test both eyes at once. (Color blindness has, however, been found to exist in only one eye, but for school purposes it will not be necessary to test the eyes separately.)

Pick out the test colors, and then mix the other worsteds upon either a gray or a white surface. Present the pale-green test color and direct the Subject to select all worsteds which resemble it. Do not designate the name of the color. Inability to name colors does not mean color blindness, but the inability to see colors rightly does indicate color blindness. Simply say to the Subject, "Give me all of the worsteds that resemble this one," at the same time handing the Subject the green skein. If the Subject does not comprehend the directions, the Examiner may illustrate the procedure by selecting several worsteds for him and then immediately mixing them in the pile. "If the Subject not only selects similar colors but also confusion colors, and in addition shows a certain hesitancy, his color sense is defective." [3]

If the Subject's color sense seems to be defective, present to him the rose skein and direct him to match this. "If besides similar skeins he also selects blue or violet he is *red-blind;* if he selects green or gray, he is *green-blind.*" [4]

Finally, present the bright-red test skein to the Subject. Because of the strong saturation of this test skein most color-blind individuals are able to match it. But if "besides reds he chooses green and brown colors darker than red, he is *red-blind;* if he selects shades of those colors lighter than red, he is *green-blind.*" [5]

The above test is by no means exhaustive in its findings. The use of such tests as Nagel's card tests has disclosed the fact that many color-blind persons have been

[3] May, *op. cit.*
[4] *Ibid.*
[5] *Ibid.*

able to pass the Holmgren test, but have been discovered by the Nagel test. But for most school purposes the Holmgren test will be adequate. Should marked or peculiar cases of color blindness be discovered, it is suggested that they be called to the attention of the expert oculist or psychologist.

Questions

1. After you have mastered the technic of the above test, examine at least 10 pupils, preferably boys. Record your findings in tabular form. Describe the case of any pupil who seems to have defective color sense.

2. Is it possible for an individual to be mildly color-blind without being aware of the condition? If so, in what way does such a person recognize colors?

3. Enumerate the school subjects studied in elementary and high schools in which color-blind students are at a disadvantage. Briefly indicate why they would be at a disadvantage in these subjects.

4. Enumerate the occupations which the color-blind should not enter. Has not the school neglected a part of its duty if it fails to inform the color-blind student of his condition and advise him to select occupations in which such ability is not essential? Why?

References

May, Charles H., *Manual of Diseases of the Eye.*

Starch, Daniel, *Educational Psychology,* Ch. ix.

Whipple, Guy, *Manual of Mental and Physical Tests,* Part I, Test 16, p. 181.

EXPERIMENT 13

Auditory Acuity

Object.—*To become acquainted with the simple methods of testing for auditory acuity.*

The presence of even partial deafness in either one or both ears interferes with the pupil's progress in school work. Often subnormal hearing is the forerunner of such conditions as total deafness and mastoiditis. The teacher ought to be able to discover cases of partial deafness so that these pupils might be referred to the ear specialist for further examination and, if found necessary, for treatment.

At first thought the examination of auditory acuity appears easy, but practically it is replete with difficulties, greater in many respects than those which confronted us in the determination of visual defects. We may use speech or instrumental tests which may be administered according to three different methods. (1) The intensity of the test sound (speech, ticking of the watch, vibration of the tuning fork, etc.) may be constant throughout the examination, but the distance of the source of the sound from the ear may be varied. (2) The distance of the source of the sound from the ear may be constant and the intensity of the test sound may be varied. (3) The distance of the source of the sound from the ear may be constant and the intensity of the sound such that one with normal acuity can hear only a percentage of the sounds.

When the distance of the source of the sound from the ear is varied, numerous difficulties arise. Standards for judging auditory acuity cannot be of universal value unless the tests are administered in all cases under the exact same conditions which were followed when the standards were obtained. But these conditions in the case of auditory tests cannot even be approximated. Examiners use rooms possessing different acoustic qualities. Even when examiners use the same room they must exercise care to keep the conditions of testing standard. For example, the windows should always be in the same position, the Subject

should always occupy the same position (preferably away from the walls so that the test sound will not be unduly reflected), the Examiner should approach the ear always along the same line of direction, the furniture should be kept in the same place, etc. From what has just been stated the difficulty of establishing universal auditory acuity standards, such as those established for visual acuity, ought to be evident. Therefore, it becomes necessary for each examiner to establish his own tentative standards; the method of establishing tentative standards will be described below.

Numerous instrument tests have been devised so that the source of sound might be at the ear itself, thus eliminating the difficulties arising from the varying acoustic properties of different rooms and different parts of the same room. Some instruments of this sort are known as audiometers[1] and usually permit the testing at the ear by the means of phone receivers. The audiometer permits the varying of the intensity of the sound. The expense and also questionable value of such instruments, however, preclude them from our discussion.

The tests described below are the speech and watch tests.

Material.—Pocket watch; measuring stick; rubber stoppers for ear plugs;[2] list of 100 test numbers (given below).

TEST NUMBERS FOR AUDITORY ACUITY[3]

(*Andrews*)

I	II	III	IV	V	VI	VII	VIII	IX	X
6	84	19	90	25	14	8	52	73	24
29	69	53	7	13	31	93	35	41	95
42	17	34	39	46	9	27	64	16	62
87	92	28	62	7	65	60	81	95	49
53	33	97	84	54	98	15	6	57	80
94	26	45	21	70	76	74	19	38	71
70	50	72	56	91	40	36	78	20	16
35	75	60	75	83	23	49	40	89	3
18	48	3	43	68	52	82	23	64	58
61	1	86	18	92	87	51	97	2	37

[1] See Whipple, *Manual of Mental and Physical Tests*, Part I, p. 200.
[2] Can be obtained from C. H. Stoelting & Co., Chicago, Ill.
[3] Whipple, *Manual of Mental and Physical Tests*, Part I, p. 204.

Procedure, I.—*Speech Test.* Use a quiet and large room; note location of furniture, position of doors and windows, etc. Decide upon the spot where the Subject is to sit, and try to obtain a place away from the walls and also far enough away from the Examiner so that the person with normal acuity [4] can hear some eight or nine out of every ten test numbers presented. If the room is short, it may be necessary to place just before the Subject a screen which will reduce the distance between the Subject and the Examiner necessary to meet the above conditions. Make a record of these conditions so that you will always be able to reproduce them when testing for auditory acuity.

Select five or more individuals whose acuity of hearing you believe is normal. Test them as follows: Direct the Subject to close his eyes and to keep his mouth shut. Close his left ear with a rubber stopper inserted in the meatus and have him sit so that his right ear is toward you. Inform him that you are going to pronounce in whispered speech a group of numbers and that he is to call out each number as soon as he hears it. With properly prepared cards the responses may be recorded either by an assistant or by yourself. It is necessary to inform the Subject just when you are going to pronounce the number in order to be certain that you have secured his maximum attention. Frequently a telegraph key and ticker are used for this purpose, but any mechanical device, such as an ordinary snapper, will serve the purpose. If an assistant is at hand, he may give the warning with the word "Now." The Examiner in no case, however, should vocally give the warning signal because such a practice is likely to cause him to vary the intensity of the whispered number. The numbers should be whispered at the end of a normal expiration. The Examiner will need to practice pro-

[4] The method for obtaining more accurate standards will be described below.

nouncing these numbers before attempting any serious examining.

Give the 100 test numbers to the individuals of apparently normal hearing until you find approximately that spot at which they hear some 80 or 90 of the numbers. This initial survey is simply for the purpose of roughly estimating the probable distance at which people of normal acuity can hear your whispered speech. Only a more thorough survey can give you tentative standards. After testing both ears of these individuals, and after having determined a spot meeting the above conditions, you are ready for actual testing and eventually for obtaining tentative standards.

Test each ear separately in the manner described above, then test both ears simultaneously, with the Subject facing you. Keep a record of each Subject's responses. It may be necessary to give very young Subjects preliminary trials in order to familiarize them with what will be expected of them. Summarize each Subject's responses by recording the percentage of correct responses, for example, right ear, 80; left ear, 82; both ears, 88. After you have examined a large number of Subjects, you are ready to obtain tentative standards which will aid you in determining whether or not a Subject's acuity of hearing is normal.

Obtain the average (mean) percentage of correct responses for the right and left ears and also for both ears. That is, if you have tested 50 subjects, you have 100 measures (percentages) which you total. Then divide that sum by 100, that is, the total number of measures. In the responses for both ears you, of course, have only 50 measures which you total, dividing that sum by 50.[5] Let us suppose

[5] See pp. 203-207 for the statistical method for obtaining the average (mean).

that you have obtained an average of 80 for the ears tested separately, and an average of 85 for both ears. All of your judgments should be made by comparing the responses of any one Subject with the appropriate average. For example, if the Subject has obtained the following record: right ear, 70; left ear, 74; both ears, 82; then we express his acuity by the following fractions: right ear, $\frac{70}{80}$: left ear, $\frac{74}{80}$; both ears, $\frac{82}{85}$.

Each Examiner must devise his own standards and, when using these standards, must examine all subjects under the same general conditions followed when the standards were obtained. Subjects who show an acuity markedly below the tentative standards should be referred to an ear specialist for further examination.

Should a Subject be unable to hear any of the numbers at the standard range, it will be necessary for the Examiner to move somewhat nearer until the Subject hears about 9 out of every 10 test numbers. In reporting the acuity of such a Subject the number of feet at which he hears the whispered speech should be given as well as the normal standard range.

If necessary, two Subjects may be tested at once, by having them face each other so that the right ear of one and the left ear of the other are toward the Examiner. If this procedure is followed, the Subjects ought to record on paper their own responses in order to prevent their responses influencing each other. Fifty test numbers may be given if time does not permit the giving of the entire series of 100.

Procedure, II.—*Watch Test.* Examine the Subjects under the same general conditions laid down for the speech test. Try to have the Subject at least 5 feet from the nearest wall, and do not yourself approach during your

examining nearer than 5 feet to any wall, in order to prevent undue reflection of the sound. Should the Subject have a watch, remove it to a point where its ticking cannot be heard. Always use the same watch in your testing, and hold the watch with the same side forward, in the palm of your hand. Draw upon the floor a chalk line, running it in the direction in which you are to advance during your examining. Place upon this line marks at distances of one foot.

Have the Subject close his eyes. Test each ear separately, then both ears simultaneously. Start close to the ear, or, when testing both ears simultaneously, close to the nose, and move out along the chalk line. At every mark say, "Now," and then have the Subject inform you whether or not he hears the ticking of a watch. Have the Subject attend to the ticking only when you give the signal. Finally, when you reach the mark at which the Subject reports that he cannot hear, record that mark, that is, the mark farthest from the ear at which he just hears the ticking. Now begin at a point several feet farther out on the line than that at which you just stopped. Approach in the direction of the Subject, and at every mark give the signal and continue to advance until you reach the point at which he reports the hearing of the ticking. Should the distances obtained by the above two methods differ, as they often do, average these distances. This average indicates the Subject's auditory acuity range.

Frequently the Subject believes he hears the ticking when he actually fails to perceive it. Therefore the Examiner should frequently move about in both directions on the line, and should also cover the watch by encircling it with both hands in order to deaden the ticking. This will enable the Examiner to determine whether or not the Subject perceives or thinks he perceives the sound.

After you have tested a number of Subjects, obtain your standards by averaging the results of these Subjects. For example, let us suppose your average or standard for the right ear and left ear tested separately is 11 feet, and for both ears tested simultaneously, 12.5 feet, then the acuity of the Subject who had a record of right ear, 9, left ear, 11, both ears, 11, would be right ear, $\frac{9}{11}$, left ear, $\frac{11}{11}$, and both ears, $\frac{11}{12.5}$.

The labor and time necessary to obtain the standards may tend to discourage the performance of the above testing. The work of obtaining standards may, after the instructor has illustrated the method, be eliminated and the students given tentative norms. With the aid of these arbitrary norms the student can at least learn the technic involved in auditory testing.

Problems

1. Examine with the speech and watch tests the auditory acuity of at least five children. Tabulate your findings.
2. Inquire of teachers of several elementary-school grades whether they have pupils who seem inattentive and slow. Learn whether these pupils have been tested for acuity of hearing; if not, perhaps you can arrange to make the test.
3. Outline the reasons you would present to a parent-teachers association or to a school board why every school should have tests given for vision and hearing.
4. If you know people who are deaf or partially deaf, inquire of them the causes of the defect. Would a periodic auditory acuity and ear examination have prevented some of these defects?

References

Starch, Daniel, *Educational Psychology*, Ch. ix.
Whipple, Guy, *Manual of Mental and Physical Tests*, Part I, Test xviii, p. 200.

EXPERIMENT 14

PERCEPTION

Object.—*To become familiar with the general nature of perception.*

"The percept, then, always contains a basis of *sensation.* The eye, the ear, the skin, or some other sense organ must turn in its supply of sensory material or there can be no percept. But the percept contains more than just sensations. . . .

"The percept that contained only sensory material, and lacked all memory elements, ideas, and meanings, would be no percept at all. And this is the reason why a young child cannot see or hear like ourselves. It lacks the associative material to give significance and meaning to the sensory elements supplied by the end-organs. The dependence of the percept on material from past experience is also illustrated in the common statement that what one gets from an art exhibit or a concert depends on what he brings to it. . . ."[1]

Material.—Stick 3 feet long; 5 common objects such as pencil, ball, etc.; picture, see **IV**; newspapers; pennies; 8 matches.

Procedure.—After performing the experiments outlined below, immediately answer the questions which follow each experiment. Several laboratory hours will be necessary for the completion of all these experiments. The instructor may select a number sufficient for one hour and assign the remainder for home work.

I. With your eyes closed examine a carpet, then an ordinary wooden floor, by running a stick over it.

QUESTIONS

1. Are you able to distinguish between the two surfaces? Do you perceive roughness, smoothness, etc.?

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[1] Betts, *The Mind and Its Education,* Ch. vii.

2. Since the stick has no sense organs, how do you perceive these facts?

II. Have an assistant place in your hands five common objects, such as a ball, pencil, etc., and with your eyes closed try to identify these objects.

QUESTIONS

1. What evidence or sensory data enabled you to identify these objects?
2. If you were mistaken in some of your attempts to identify the objects, what caused these errors?

III. With your eyes open examine the same objects used in the experiment **II.**

QUESTIONS

1. What part does vision play in your perceptions?
2. Have you any reason, based upon your general observation of young children, to suppose that the visual sensations are of secondary importance in the perception of spacial objects? If so, why?
3. Is there any evidence that visual sensations, combined with tactual sensations, can of their own accord arouse spacial perceptions? If so, give illustrations.

IV. Look at a picture, preferably a landscape scene.

QUESTIONS

1. How does the artist secure depth in his picture and also give objects an appearance of reality? Give attention to the proportion of the various objects; use of shadows; use of different colors, also different shades of the same colors; vagueness and clearness of outline; partial covering of distant objects by nearer objects, etc.
2. What are the chief defects of the art of ancient Egyptians and the drawings of children?

V. Look at an actual landscape scene.

QUESTIONS

1. How do you, in part, perceive distance, etc.?

2. In what way does the artist make use of the various stimuli that tend to give the effect of size, distance, etc.?

VI. Focus one eye upon a relatively near object, but in such a way that objects at a greater distance are partially in the field of vision. Move the head from side to side.

QUESTIONS

1. What effect has the moving of the head upon the near and distant objects? Do any of the objects seem to move relatively faster than others?

2. Do you believe that the phenomenon described in the preceding question serves as a partial basis for perceiving distances? (Distances can be judged in this manner, but perhaps binocular vision renders this basis for judgment relatively unnecessary. See **VII** below.)

VII. Part 1.—Hold the unfolded (two) sheets of a newspaper one foot from the eyes so that both eyes focus directly upon the crease, that is, the center of the paper. Close the left eye, and without moving the right eye note the reading material of one particular line and how much of the material to the right and to the left you can see. Now close the right eye and with the left eye, in a similar manner, note the material you can see, both to the right and left. With both eyes open, note the material to the right and to the left that you can see. Keep a record of the letters and words seen when you secure the above conditions.

QUESTION

1. Do you get similar views of objects (the newspaper print in this case) with the right and with the left eye? If not, describe the differences, by giving the letters and words seen by each of the eyes, and also by both eyes.

VII. Part 2.—Now hold the paper at arm's length from your eyes, and in a manner similar to that described in **VII, Part 1** perform the experiment.

QUESTIONS

1. Answer the preceding question given in **VII, Part 1.**

2. Is the disparity between the two images of the print less or greater when the newspaper is near or at a distance from the left and right eye?

3. In one's observation, instead of two vertical planes, there exists an infinite number, with a corresponding number of images and disparities. What part does the disparity between two, or among more, retinal images play in judging distances and the relief of objects?

VIII. Hold a pencil horizontally so that the rubber end rests against the nose. (*a*) Look at the point of the pencil first with the left eye and then with the right eye. (*b*) Now with both eyes open fixate the point, then the near end, and lastly the middle.

QUESTIONS

1. What evidence do you find of two retinal images in (*a*)? What effect is produced by rapidly closing and opening each eye alternately?

2. Describe the three images obtained in (*b*) and illustrate them by simple drawings.

IX. (*a*) Close one eye and with a pencil held at the end in each hand bring the points of the pencils together about a foot in front of the face. Do this quickly several times, but always start the arms from the side. Then perform the experiment with both eyes open. (*b*) Make a dot on a piece of paper and place the paper on the desk. First, with the left eye closed, then with the right eye closed, and finally with both eyes open, touch this dot with a pencil held in the right hand. Move the paper slightly for each trial and always start the arm from the side. Per-

form this experiment several times and record the number of errors you make and the number of successes you achieve.

QUESTIONS

1. What, if any, advantage has binocular vision over monocular vision?

2. If a stereoscope is at hand, briefly describe, in the light of the above experiments, the principles upon which it produces the three dimensions.

X. The following experiment can be best performed as a class experiment with the assistance of nine students, one of whom is to act as a Subject and the other eight as Assistant Examiners. Be certain that the acuity of hearing of both ears of the Subject is approximately the same. Blindfold and seat the Subject in the center of the room, place the Assistant Examiners in the following positions: one directly in front of the Subject, one directly to the right of the Subject, one directly to the rear of the Subject and one directly to the left of the Subject. Place midway between each of these Examiners the other four Examiners, so that the Subject is at the center, and all the Examiners are at an equal distance away from him. Let this distance be no greater than 10 feet or less than 6 feet. Each Assistant Examiner is to be equipped with one matchstick and two pennies. The Assistant Examiners are to place the tip of the match just between the pennies which are to be held between the forefinger and thumb, so that when the match is pulled out a click will be heard. They will need to practice this until a fairly uniform click is obtained. When the Assistant Examiners and the Subject are in their designated positions, let the Chief Examiner designate, by pointing, which Assistant Examiner is to make the click. Let the Subject indicate the direction from which the sound comes. Note the correct and incorrect responses.

QUESTIONS

1. What seems to be the basis for judging the direction of sound?

2. On what grounds can you explain the Subject's failures, taking for granted that none of the errors were due to inattention or auditory defect?

3. If it were possible to test the perception of sound in the vertical plane, that is, directly below and above the Subject, with what accuracy do you suppose he would judge the direction of the sound?[2]

XI. Close your eyes and then have an assistant touch you several times, lightly, upon the back of the uncovered arm. Open your eyes and attempt to locate each point immediately after being touched.

QUESTIONS

1. Did you approximately locate the points touched?

2. How did you locate the place of the stimulus? Does not a pencil point applied to two different parts of the skin feel the same? How then did you distinguish and locate the spots? (See below.)

No doubt the preceding question has given you some trouble. Introspection does not seem to aid you, and you are simply forced to reply, "I know that the points are different and hence I was able to locate them." Unlike the previous experiments performed no sense data seemed to exist upon which to base your perceptions. To these unanalyzable sensory data we usually apply the designation, "local sign." The local sign gives us the location of the point stimulated. Upon certain parts of the body, such as the back, such points cannot always be definitely located. The theory of the local sign is not, however, accepted by all psychologists. Some believe that the stimu-

[2] C. H. Stoelting & Co., Chicago, supply a sound cage which may be used to produce sound in any plane.

lation of each point on the skin causes a reflex movement and that this reflex is different for each point. Still another group believes that the point of contact, as a result of previous association, recalls a visual picture of the point touched.

General Questions

1. In narrative form briefly summarize the general nature of perception.

2. Why is it impossible for pupils to build up accurate perceptions solely from textbook descriptions?

3. In what way has your study emphasized the necessity of proceeding from the concrete to the abstract when teaching the young pupil?

4. How can you improve your perceptions?[3]

5. Draw a line (without the aid of any measure) just five inches long. Chalk out on the floors and walls of a corner of a room the space occupied by a cord. How accurate were your estimates?

6. One teacher required the pupils to learn verbatim the table of weights and measures; another teacher first had the pupils empty the pint measure into the quart and gallon measures, etc., and also measure the length of a board with a yard measure, a foot measure, and an inch measure. Which procedure would you follow? Why?

7. Of what value are diagrams in teaching pupils how to solve arithmetical problems?

8. One group of pupils observe numerous details about the house cat; another group observe few details but attach to each detail its function. Which group has the truer perceptions? Why?

9. (*a*) Measure off on the desk top, by means of the eye, 24 inches. (*b*) Put your finger on the starting point at the left, then close your eyes and move your finger across the desk so that you measure off the same distance. How accurate were your estimates? (*c*) If possible, obtain the class average of

[3] See Betts, *The Mind and Its Education*, Ch. vii.

these two estimates and compare your estimates with these averages.

10. Why is it necessary to make use of the sense of touch in training children in perception of objects? Give three illustrations of such training drawn from school work.

11. Why did Froebel, the founder of the kindergarten, maintain that perception of form is best gained in connection with manual reproduction?

12. To what extent do you notice and respond to the æsthetic values in classical music? Effects of architecture? Paintings? Poetry? To what extent does experience and training, or lack of experience and training, explain your responses?

13. To what extent are you skilled in social perception? To what extent are you able to notice and judge the joy, anger, displeasure, and humor of your friends? Are you as successful in judging the same and other traits in perfect strangers? If not, why? What is the basis for your judgment in these cases?

References

BETTS, G. H., *The Mind and Its Education,* Ch. vii.
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CAMERON, E. H., *Psychology and the School,* Ch. v.
COLVIN and BAGLEY, *Human Behavior,* Ch. xiii.
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JAMES, William, *Psychology, Briefer Course,* Ch. xx; *Talks to Teachers,* Ch. xiv.
LA RUE, D. W., *Psychology for Teachers,* pp. 126-132.
NORSWORTHY and WHITLEY, *Psychology of Childhood,* Ch. vii.
SEASHORE, C. E., *Introduction to Psychology,* Ch. viii.
WOODWORTH, R. S., *Psychology,* Ch. xvii.

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[4] Needless to say, complex situations such as those referred to in this question cannot at all times be completely or accurately analyzed. Numerous data, in fact, can not be observed, for example, the glandular changes in those who are angry or joyful. Relatively few people have these perceptions so fully developed that they can infallibly interpret all behavior. The psychologist is at present engaged in developing scientific measures for some of these traits in order to supplement our inadequate social judgments. The greatest progress in devising measurements have been those for measuring general intelligence and will.

EXPERIMENT 15

Errors of Perception: Illusions

Object.—*To gain a more complete knowledge of perception through a study of illusions.*

Inadequate interpretation of objectively existing stimuli often results in an error of perception, that is, an illusion. When one mistakes the rustling of the wind for the approaching footsteps of a friend, he is experiencing an illusion. An illusion is thus a false perception which is experienced under like conditions by practically all normal people, who, however, as a result of a more extended experience recognize the error of perception. The study of illusions, and their causes, aids one in understanding more thoroughly the process of perception.

Material.—Ice; matches; an ordinary drawing compass.

Procedure, I.—Study each of the groups of figures numbered Figs. 1 to 6. First determine what the illusion is and then attempt to explain what causes it. Report your experiment by answering the questions given below.

Questions

1. Does the inability of the observer to isolate the parts to be observed in the above figures exert any force in causing the errors of perception? If so, indicate in what way.

2. What part do you suppose the above type of illusion plays in the tailoring of clothes, designing of goods, architecture, etc.? Give three definite illustrations which you have observed of the use of this principle.

Procedure, II.—Study the Figs. 7 and 8 on page 55. Note that the flat figures appear as solid objects.

Cross the middle finger over the index finger so that a pencil, or marble, can be placed between the ends of the two fingers. Now place the pencil, or marble, between the

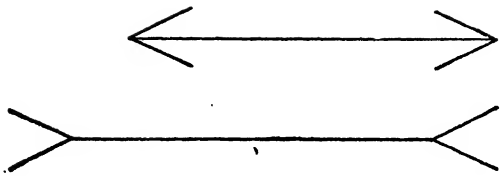

FIG. 1.

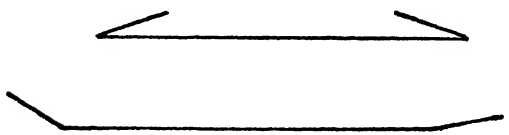

FIG. 2.

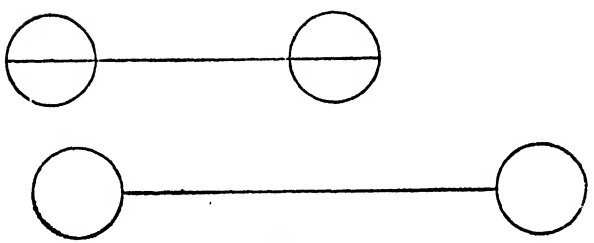

FIG. 3.

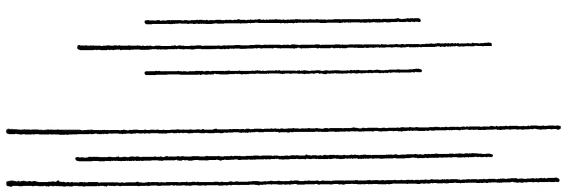

FIG. 4.

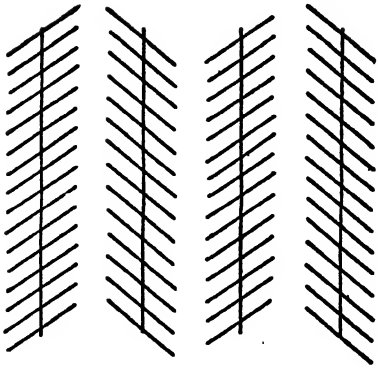

FIG. 5.

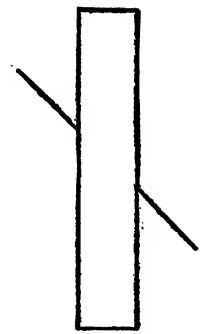

FIG. 6.

two fingers when they are in their customary position. Note the number of objects felt when the above conditions are obtained.

QUESTIONS

1. What part does previous association and experience play in the above illusions?
2. Why does a slight error in spelling often pass unnoticed?
3. What light does this type of illusion throw upon the moving pictures, which are simply a series of snapshots?

Procedure, III.—Study the Figs. 9 and 10 opposite. Note whether the vertical or horizontal lines appear longer.

The sense organs of pressure are more numerous directly below and above the middle of the mouth than just below and above the ends of the mouth. Separate the points of a compass to the extent of one-half to three-quarters of an inch and draw the points lightly across the mouth so that one point passes below and the other above the mouth. Note whether or not the points of the compass seem to widen out.

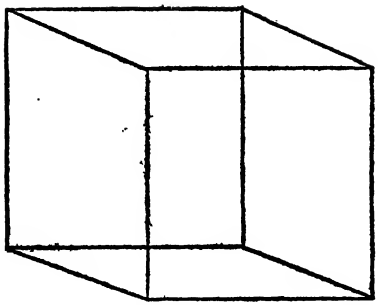

FIG. 7.

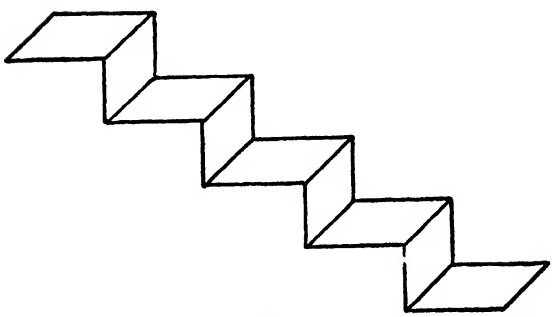

FIG. 8.

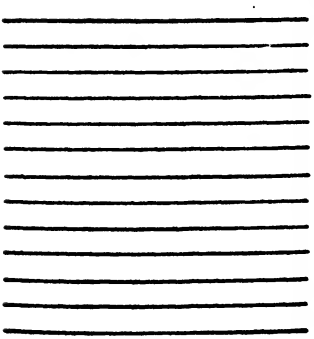

FIG. 9.

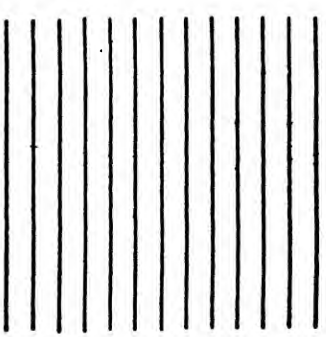

FIG. 10.

QUESTIONS

1. Briefly describe the part played in the above illusions by the general nature of the sense-organs.
2. Why should thin people wear clothes which particularly emphasize horizontal lines?
3. Why does a distant hill appear steeper than it really is?

Procedure, IV.—Blindfold a Subject and let him hear you light several matches; then quickly draw across the back of his hand a piece of ice.

QUESTIONS

1. What sensation does the Subject experience? What effect has mental set on such an illusion?
2. Why do we often see or hear a certain thing, when we want to see or hear it, when, as a matter of fact, it is not present?

GENERAL QUESTION

On the basis of the above experiments enumerate and describe at least four factors which tend to cause illusions.

REFERENCES

See references at the end of Experiment 14.

EXPERIMENT 16[1]

MENTAL IMAGERY

Object.—*To investigate the various types of imagery, and their distribution in the same and in different individuals.*

"In the image, an object of sensation or of perception comes into the stream of consciousness without the object itself being actually present. . . .

"Images may in a certain sense take the place of percepts, and we can again experience sights, sounds, tastes, and smells which

[1] Adapted in part from experiments described in Betts, *The Distribution and Function of Mental Imagery.*

we have known before without having the stimuli actually present to the senses."[2]

Individuals will differ markedly in their responses to the following experiments. Many will find it difficult, and often impossible, to perform the entire experiment or completely answer all of the questions. Those who experience such difficulties are advised to note and record the nature of their difficulties, but to persist in their attempts to perform as much of the experiments as possible.

Procedure, I.—Look at a closed book. Note its title, name of the author, color of cover, etc. Now close your eyes and recall in your "mind's eye" all of the qualities you observed when the various stimuli were actually present to the senses.

QUESTIONS

1. Compare the image of the book with the actual percept by answering the following questions:

(*a*) Does the image appear as detailed and vivid as the percept? If not, describe the chief differences.

(*b*) Which appears more real and is in possession of greater sensory quality? In what ways?

(*c*) Which is more permanent? If one is more fleeting, describe its lack of stability.

(*d*) Can you observe in the image facts of which you were not aware when the object was present to the senses? Why?

2. Summarize your answers to the above series of questions by giving an account of the chief characteristics of an image.

3. Comment upon the following statement: After all, the chief distinguishing feature of an image is the fact that it is the experiencing of an object of sensation or perception without that object itself being actually present to the senses; all other distinguishing features are secondary in importance.

Procedure, II.—The four grades, or degrees, of clearness and vividness printed in the key below will give you

[2] Betts, *The Mind and Its Education*, Ch. viii.

a standard by which to determine your answers to the questions of the tests. Read and reread these directions until you fully understand what each grade or degree means. Answer *all* of the questions by simply writing the *number* (3, 2, 1, or 0) which corresponds to the degree of clearness and vividness upon which you decide for your image. Do not hurry in answering the questions. Answer each question strictly upon its own merits, that is, regardless of how you have answered any other one. Introspect with your eyes closed.

Key for Answering Questions

With respect to the mental picture suggested in each of the questions of the test, is the image which comes before your mind,

3. *Perfectly clear and as vivid as the actual experience,* or
2. *Moderately clear and vivid,* or
1. *Vague and dim,* or
0. *No image present at all,* you only *knowing* that you are thinking of the object.

You will find fifty-six questions, arranged in seven groups of eight questions each. These groups contain the following types of imagery: I. *Visual,* II. *Auditory,* III. *Cutaneous,* IV. *Kinæsthetic,* V. *Gustatory,* VI. *Olfactory,* and VII. *Organic.* Place the above seven headings upon paper, allowing lines for eight responses for each heading; number these lines from 1 to 56. If you are certain that you understand the key for answering questions, begin work.

I. Visual Imagery

Think of some relative or friend whom you frequently see, considering the picture that rises before your mind's eye, and classify the images suggested by each of the following questions as indicated by the degrees of clearness and vividness specified in the Key:

A. *As to* **form, feature,** *etc.:*

1. The exact contour of face, head, shoulders, and body
2. Characteristic poses of head, attitudes of body, etc.
3. The precise carriage, length of step, etc., in walking
4. Cut of clothes, style of collar, tie, hat, shoes, etc.

B. *As to* **colors:**

5. The exact complexion, both as to color and clearness of skin
6. The different colors worn in some familiar costume
7. The precise shade of color of the hair
8. The precise shade of color of the eyes

II. Auditory Imagery

Think of each of the following sounds, considering carefully the image which in each case comes to your mind's ear, and classify the images suggested by each of the following questions as indicated by degrees of clearness and vividness specified in the Key:

9. The beat of rain against the window
10. The clink of glasses
11. The honk of an automobile
12. The mewing of a cat
13. The clapping of hands in applause
14. The rustling of a newspaper
15. The swish of a silk dress
16. The sound of a clock striking

III. Cutaneous Imagery

Think of "feeling" or touching each of the following, considering carefully the image which comes to your mind's touch, and classify the images suggested by each of the following questions as indicated by the degrees of clearness and vividness in the Key:

17. Velvet
18. Wet soap
19. Sand

20. A smooth doorknob
21. A fur muff
22. The prick of a pin
23. The sting of cold against the face
24. The heat of a burning sun

IV. Kinæsthetic Imagery

Think of performing each of the following acts, considering carefully the image (do not confound this with an incipient movement of the muscles concerned) that which comes to your mind's arms, legs, lips, etc., and classify the images suggested by the degrees of clearness and vividness specified in the Key:

25. Running up stairs
26. Drawing a circle on paper
27. Lifting a heavy weight
28. Rising out of a low chair
29. Counting to 10 orally as fast as you can
30. Passing a heavy dish at the table
31. Nodding your head in assent
32. Stooping down to tie your shoe

V. Gustatory Imagery

Think of tasting each of the following, considering carefully the image which comes to your mind's mouth, and classify the images suggested by each of the following questions as indicated by the clearness and vividness specified in the Key:

33. Salt
34. Granulated (white) sugar
35. Chocolate
36. Vinegar
37. Coffee
38. Fried eggs
39. Peanuts
40. Your favorite candy

VI. Olfactory Imagery

Think of smelling each of the following, considering carefully the image which comes to your mind's nose, and classify the images suggested by each of the following questions as indicated by degrees of clearness and vividness as specified in the Key:

41. Onions
42. Coffee
43. Cooking cabbage
44. Camphor
45. Fresh paint
46. Your favorite perfume
47. Cigar smoke
48. Some odor which you particularly dislike

VII. Organic Imagery

Think of each of the following sensations, considering carefully the image which comes before your mind, and classify the images suggested as indicated by degrees of clearness and vividness specified in the Key:

49. Headache
50. Fatigue
51. Hunger
52. A sore throat
53. Well-being, or vigor and vitality
54. Drowsiness
55. A cold in the head
56. Thirst

Results: Obtain for each type of imagery the total scores by adding the eight key numbers you assigned to each question. Under the direction of your instructor also obtain the scores of other members of your class. Use a table similar to the one suggested below for recording the scores.

SCORES IN IMAGERY

Subject's Name	Visual	Auditory	Cutaneous	Kinæsthetic	Gustatory	Olfactory	Organic
.....							
.....							
.....							
.....							
.....							
Total							
Mean							

QUESTIONS[a]

1. On the basis of your personal scores, arrange seven types of imagery in the order of strength. Do you belong entirely to one type, or are you a mixed type?

2. Arrange the seven types of imagery in the order of strength for the entire class. What types seem the most prominent? By inspecting your table do you find individuals who can be assigned solely to one of the following types: visual, audil, or motor? Or do the majority belong to the mixed type?

3. By inspecting the table find one student whose record differs markedly from your own. Discuss this difference with him and see if you can appreciate the fact that although his mental scenery differs from your own he still seems to use the same vocabulary as you do. Give a brief account of this discussion.

4. Does any student seem, because of his low scores, to belong to the verbal imagery type? In your own reading and thinking do you find images of objects occurring spontaneously? Do you find evidence in your own case of verbal imagery? (To answer

[a] A more thorough study than that which you have just conducted is necessary before you can approach accuracy in the answer to these questions. Your instructor will aid you in determining whether or not the results you have obtained are in keeping with the most recent studies of imagery.

this question the student may need the assistance of either the instructor or a textbook.)

5. What relationship seems to exist between the various types of imagery; is there a tendency for one who ranks high in one type of imagery to also rank high in another type? (This question may be answered partly by inspection of the table, or, more accurately, by computing the coefficient of correlation.) [4]

6. Criticize the following statement: Discover the dominant imagery possessed by the pupil, and in your teaching appeal to this imagery.

7. Have you any reason to believe that an appeal to the imagery in which a pupil is apparently weak may result in the arousal of images in which he is particularly strong? Substantiate your answer by as many facts as you can gather.

8 Why in teaching such a subject as spelling should the teacher appeal to as many sense avenues as possible?

9. Experimental studies indicate that imagery tends to decrease in clearness and richness with age. Suggest means by which the imagery may be kept active.

10. If the images which pupils are to possess are to be clear and accurate, what should be the nature of their sensory training and their perceptions? Illustrate with phases of school subjects other than those phases referred to in your previous answers.

References

Betts, G. H., *The Mind and Its Education,* Ch. viii.

—— *Distribution and Functions of Mental Imagery.*

Starch, Daniel, *Educational Psychology,* pp. 166-169.

See also references at end of Experiment 17.

[4] For methods of computing the coefficient of correlation see pp. 209-213.

EXPERIMENT 17[1]

IMAGINATION

Object.—*To study the general nature of imagination and the relationship of imagination to the enjoyment of literature.*

"Imagination is not a process of thought which must deal chiefly with unrealities and impossibilities, and which has for its chief end our amusement when we have nothing better to do than to follow its wanderings. . . . It is the process by which the images from our past experiences are marshalled and made to serve our present. Imagination looks into the future and constructs our patterns and lays our plans. . . .

"Nothing can enter the imagination, the elements of which have not been in our past experience and then been conserved in the form of images. . . . It takes the various images at its disposal and builds them into *wholes* which may never have existed before, and which may exist now only as a creation of the mind. And yet we have put into this new product not a single *element* which was not familiar to us in the form of an image of one kind or another. It is the *form* which is new; the *material* is old."[2] Imagination thus consists not only in putting images together but also in taking complex images apart so as to produce exactly what we have previously experienced or to create the new which may never have existed before, that is, imagination may be *reproductive* or *creative*.

Procedure.—Select one of your favorite poems or pieces of literature. Think of or read the selection through as you ordinarily would do (not in connection with this experiment, but naturally). Note whether or not there comes before your mind the various images which the poet or author tends to suggest.

[1] Adapted in part from experiments described in Betts, *The Distribution and Functions of Mental Imagery*.

[2] Betts, *The Mind and Its Education*, Ch. ix.

Questions

1. Do there come before your mind's eye *visual images* of the various persons, places, and objects suggested or described? If so, are these images very vivid and clear, only moderately so, or vague or dim?

2. Do there come to your mind's ear *auditory images* of the sounds which are suggested or described? Vivid? Moderate? Vague?

3. Do there come to your mind's muscles *images of the movements* suggested or described? Vivid? Moderate? Vague?

4. Do there come to your mind's skin *images of touch* as suggested or described? Vivid? Moderate? Vague?

5. Do there come to your mind's mouth and nose *images of tastes or smells* suggested or described? Vivid? Moderate? Vague?

Note to the Student: It is advisable that the student before answering the following questions discuss the various points mentioned in these questions with several other members of the class, especially with those students who have reported few or no images.

6. Or do you not experience these images at all, but only *feel* or *know* or *understand* the meaning of the piece?

7. If the images suggested above do appear when you think of or read the piece, is it the images you love to think about and dwell upon, or is it the *thoughts,* the *meaning,* the *feeling,* the *sentiments,* the *language,* the *rhythm,* or some other qualities?

8. Does the absence of imagery mean inability to interpret and appreciate literature?

9. Add any further explanation of your own to show how you think about the piece or why you like it.

10. Briefly summarize your interpretation of the above experiment by indicating the relationship of imagery to the enjoyment of literature.

11. Comment upon the following statements: The reading of a poem may fail to call before one's mind images, but still appreciation and enjoyment may exist. This appreciation, however, could not exist unless the person had at some time in his life been in contact with concrete objects, etc., similar to those referred to in

the poem or in contact with objects which might serve as a basis for understanding those things to which the poem referred.

12. What is the material (the mental content) out of which imagination builds its structures?

13. What is the basis for training the imagination? Illustrate such training in the school subjects of literature and geography.

14. A fifth-grade class in geography, after it had studied about mountains, was asked the question, "Which is higher, the tall chimney (showing a factory smokestack through the window) or a mountain?" Nearly half the class said, "The chimney is higher," some explaining that if the mountain "went straight up like the chimney it would be the higher." Explain these errors from the standpoint of imagination.

15. Take a fact not directly presentable to the senses, such as a historical event, and explain the way in which the pupils' minds grasp the event. How does the choice of words indicate whether or not the pupils have the power to construct images?

References

Betts, G. H., *The Mind and Its Education,* Ch. ix.
——*Distribution and Functions of Mental Imagery.*
Averill, E. A., *Psychology for Normal Schools,* Lesson 36.
Colvin, S. S., *The Learning Process,* Chs. vii, viii.
James, William, *Psychology, Briefer Course,* Ch. xix.
La Rue, D. W., *Psychology for Teachers,* Ch. xi.
Norsworthy and Whitley, *Psychology of Childhood,* Ch. ix.
Woodworth, R. S., *Psychology,* Ch. xix.

EXPERIMENT 18

Association: Primary Laws

Object.—*To determine the general nature of association and to formulate the primary laws of association.*

"Whence came the thought that occupies you this moment, and what determines the next that is to follow? Introspection reveals no more interesting fact concerning our minds than that our thoughts move in a connected and orderly array and not in a

hit-and-miss fashion. Our mental states do not throng the stream of consciousness like so many pieces of wood following each other at random down a rushing current, now this one ahead, now that. On the contrary, our thoughts come one after the other, as they are beckoned or *caused.* The thought now in the focal point of your consciousness appeared because it sprouted out of one just preceding it; and the present thought, before it departs, will determine its successor and lead it upon the scene. This is to say that our stream possesses not only continuity, but also a *unity;* it has coherence and system. This coherence and system which operates in accordance with definite laws, is brought about by what the psychologist calls *association.*"[1]

Material.—Paper with at least 30 lines, for use in **II.**

Procedure, I.—Administer the following uncontrolled association test to a classmate, or preferably to a person not familiar with the doctrines of psychology. Give the following instructions:

"I want to see how many words you can think of and write down on this piece of paper. I shall name a word, and you are, when I tell you, to write this word down on the first line and then continue to write directly under it all the other words that come to your mind. Work as fast as you can but remember that you are to keep writing down the words in the order in which they come to your mind. Continue to write until I say, 'Stop!' Do you understand what you are to do? Ready—the word is . . ."[2]

Stop the Subject when he has written 20 words. Immediately have the Subject begin with the first word and try to tell you why he gave each word. Keep a brief record of his statements for your notebook and further interpretation.

QUESTIONS

1. Briefly describe the manner in which the words seem to occur. Do they occur in a hit-and-miss fashion?

---

[1] Betts, *The Mind and Its Education,* Ch. x.

[2] Start the Subject with some such word as *sing* or *theater,* etc.

STIMULUS WORDS

1. long
2. bed
3. coat
4. top
5. green
6. slim
7. hot
8. bird
9. north
10. beautiful
11. door
12. pluck
13. peace
14. bestow
15. corn
16. begin
17. condemn
18. dishonest
19. male
20. strike
21. church
22. cold
23. page
24. wish
25. yes
26. appeal
27. knife
28. false
29. error
30. table

2. Was the Subject unable to explain the occurrence of any word? If so, what explanation would you offer for his inability?
3. What is the general nature of association?

Procedure, II.—Do not examine the preceding list of words until instructed to do so. Completely cover the list of words with a sheet of ruled paper of 30 lines. Divide this sheet in three equal parts by vertical lines. Head the first column with the word "Stimulus," the second column with the word "Response," and the third column with the word "Analysis."

You are now ready to perform the experiment. Gradually slip the paper down until the first stimulus word is uncovered. *Immediately* write on the sheet of paper in the second column, under "Response," the first word that comes to your mind, then in the first column write the stimulus word. In a similar manner uncover the other words.

QUESTIONS[3]

1. Analyze your response and the stimulus word and attempt to determine the kind of relationship which holds between them. Briefly (if possible by one word), place a record of this analysis on the appropriate line in the third column. For example:

Stimulus Word	Response Word	Analysis
bad	good	Opposites
chair	leg	Part of the whole—occur together

A generalization based upon your analyses will give you the three *primary laws* of association, first formulated by Aristotle. What are these laws?

[3] Questions which require the application of the principles so far developed in this experiment will be found in Experiment 19. However, do not read these questions until you have performed Experiment 19.

2. Are there any of your responses which seem to be unusual, in that few people would be likely to give the same ones? Compare your responses with your classmates in order to discover such associations. Discuss these responses with your classmates and attempt to explain the differences in association.

REFERENCES

See references at the end of Experiment 19.

EXPERIMENT 19

ASSOCIATION: SECONDARY LAWS

Object.—*To formulate the secondary laws of association.*

Material.—Plain white paper 8 inches square, with rectangular aperture sufficiently large to expose a line 2 inches long; the aperture is to be cut in the center of the paper.

Procedure, I.—On the basis of the performance of the previous experiment you have formulated the three primary laws of association. In the experiment which follows you are to formulate the secondary laws of association.

Do not examine the following six lists of words until instructed to do so. Each list contains seven nonsense syllables; next to each nonsense syllable appears a one-syllable, three-letter English word, for example,

kov **sea**

Directly below the seven pairs just described appear the same nonsense syllables but without their English equivalents. Place the paper with the aperture over these pairs so that List I appears directly in the center of this aperture.

You are now ready to begin the experiment, but be certain that you understand the following directions before you actually start. When you feel you understand these directions, slide the paper down until the first pair appears. Say these two syllables (the nonsense syllable and the

English word) to yourself, twice and only twice, with the intention of memorizing them. Then slide the paper down so that the next set of pairs is exposed, and memorize this pair in like manner. Continue until the seven pairs have been exposed. *Give to each pair the same amount of time,* at the most five seconds.[1] Your classmate may give more or less time than you do, but it is imperative that each pair be given the same amount of time by you whether it be three, five, or more seconds.

With another sheet of paper, containing at least seven lines, and designated as "Response List I," uncover one at a time the nonsense syllables appearing below the seven pairs, which you must be certain to keep covered at all times. As you uncover each word, place your response on the appropriately numbered line. If you cannot within ten seconds recall the word, leave a blank space and pass on to the next stimulus word. After you have tried to give a response for each stimulus nonsense syllable, write in the nonsense syllable on the proper lines.

Before reading further perform at once the experiment in a similar manner with Lists II, III, IV, V, and VI.

Tabulate the number of your correct responses and record them in a table similar to the one on page 75. Also obtain the results of nine or more of your classmates. In the table, "Primacy" refers to the first pair occurring in each list; "Recency" refers to the last pair in each list; "Frequency" refers to the three different pairs in Lists II, III, and VI, which occur twice; "Intensity," to the three different pairs in Lists I, IV, and V, which appear in large type; and "Miscellaneous" refers to the other words not provided for by the above enumerated headings.

For each Experimenter the greatest number of possible

[1] The entire class may perform this experiment at the same time; the instructor by tapping can then insure a uniform time for all words.

LIST I

hik	boy
dex	run
vos	fat
TEZ	WAY
gur	use
lak	did
zup	cut

vos
lak
TEZ
hik
zup
gur
dex

LIST II

biz	law
wox	tip
mun	new
fep	egg
Wox	tip
kel	fig
gup	old

fep
kel
gup
wox
mun
biz

LIST III

dur	fly
gop	day
kef	run
tas	age
gop	day
wec	out
vud	any

wec
kef
gop
dur
vud
tas

LIST IV

puk	arc
cos	fit
SOF	PIN
nar	man
zik	leg
pum	die
haf	box

pum
zik
haf
nar
cos
SOF
puk

LIST V

cey	met
jev	sky
sik	may
HAL	**CUE**
tir	eat
fow	one
sug	but

HAL
sug
tir
cey
jev
sik
fow

LIST VI

kir	sin
mur	two
baz	kin
lef	beg
los	fit
baz	kin
dix	ton

mur
los
lef
dix
baz
kir

CORRECT RESPONSES

Name of Subject	Number of Correct Responses for				
	Primacy	Recency	Frequency	Intensity	Miscellaneous
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Total....					
Percentage of Correct Responses					

correct responses for "Primacy" is 6; for "Recency," 6; for "Frequency," 3 (counting each repetition as 1); for "Intensity," 3 and for "Miscellaneous," 27. Obtain the total of correct responses for each column, and then work out the percentage of correct responses for each column. For example, if you have the results for "Frequency" of ten subjects, then the greatest possible number of correct responses would be 30 (10 x 3), and if 20 of these responses were correct the percentage would be 66 per cent.

QUESTIONS

1. Study the results shown in your table and formulate the four secondary laws of association.

2. A fifth primary law is sometimes given as *emotional congruity,* that is, other things being equal, that association which is in keeping with our present feeling will prevail. Give illustrations of this law.

3. The present tendency in psychology is to subordinate the various so-called primary and secondary laws of association under one general law. This general law may be given to the effect

that things which have been associated together in experience tend to reinstate themselves together. Does this general law cover all of the cases brought forth by your studies? If so, indicate how.

4. What part does association play in memory and in learning?[2]

5. In teaching the "spelling demons," such as *receive* and *believe*, why is it a good teaching aid to write with colored chalk upon the board the combination of letters which usually give difficulty, calling the pupils' attention to the combination? What laws of association are illustrated by this teaching aid? Illustrate the use of other laws of association in teaching spelling.

6. Briefly indicate the value and use of some of the laws of association in teaching important and necessary dates and events in history.

7. In teaching the pronunciation of foreign or unusual English words, what laws of association may the teacher apply? Illustrate.

8. Why do young children commonly define a word in terms of its use?

References

Betts, G. H., *The Mind and Its Education*, Ch. x; also pp. 170-171.
Averill, E. A., *Elements of Educational Psychology*, Lesson 9.
Bagley, W. C., *The Educative Process*, Ch. xi.
Colvin and Bagley, *Human Behavior*, Ch. xvi.
Colvin, S. S., *The Learning Process*, Ch. x.
James, William, *Psychology, Briefer Course*, Ch. xvi.
La Rue, D. W., *Psychology for Teachers*, Ch. x.
Seashore, C. E., *Introduction to Psychology*, Ch. xi.
Woodworth, R. S., *Psychology*, Chs. xv, xvi.

[2] See Betts, *The Mind and Its Education*, pp. 170-171.

EXPERIMENT 20

The Effect of Environment upon Associations

Object.—*To show the effect of environment and training upon our associations.*

In spite of our attempts to conceal our mental content we often give evidences of that content by our words and actions. For example, the stimulus word *note* is very likely to bring forth different responses from the musician, banker, and teacher. By constructing a list of words containing relevant and irrelevant words, it is possible to determine whether a student has had a course, for example, in psychology. To such a student the following words are very likely to call forth definite associations gained through the study of psychology: nonsense, stimulus, kinæsthetic, etc., while to the average person such words will for the most part have no special psychological meaning. We are all aware of the fact that children in their oral language give evidence of their home and street associations.

The association reaction is one of the fundamental principles in psychoanalysis. Psychoanalysis is too specialized a subject for us to consider in detail, but we can demonstrate the use of the principle in detecting guilt for some act, thus illustrating the influence that environment plays in our associations. The experiment described below can not be performed with those who are familiar with the stimulus words or content of the two notes, hence it is described merely for the purposes of illustration.

Procedure.—Two notes were enclosed in two envelopes, which were then given to two students who were told to open the envelopes as soon as they left the classroom, and do exactly as the notes instructed them.

Contents of Note I

After reading this first sentence, immediately go to the second floor before reading further.

You have now reached the second floor and you are to repeat to

yourself five times the following, "I am on the second floor." Now walk in the direction of an entirely different staircase from the one you have just descended. While walking count your change and place it in an entirely different pocket. Before ascending the staircase repeat five times, "I must leave the second floor." When you reach the top of the staircase, make certain that your necktie is properly arranged, and then put this note in the pocket with your change. Now say five times, "I must not let anyone see this note." Return to the classroom.

CONTENTS OF NOTE II

You are to wait outside of the door until the other member of the class returns. You are both to enter the classroom together. Do not ask him any questions. Do not permit him to tell you anything.

When the two students returned to the room, they were assigned blackboard spaces and were told that a group of words would be given to them, one at a time, and that they were to write immediately upon the board the first word that came to their minds. Four other students (two for each Subject) were required, with the aid of two stop watches, to obtain and record the time elapsing (that is, the reaction time) between the stimulus word and the beginning of the writing of the response word. One student obtained the time and the other recorded the time.

The stimulus words, responses, and reaction time[1] for two subjects are shown in tabular form on page 79.

For the most part, the reaction time for the significant and relevant words of the Subject who had Note I (that is, the guilty person) is greater than the reaction time of the Subject who had Note II (that is, the innocent person). Usually the response words of the guilty person are either exactly the ones which would be expected because of the

[1] In the table fractions are disregarded. That is, 1 second means less than one or exactly one.

STIMULUS WORDS, RESPONSES, AND REACTION TIME

Stimulus Word	Student with Note I		Student with Note II	
	Response	Seconds	Response	Seconds
1. bread	butter	1	butter	1
2. pocket	book	2	book	1
3. guilty	no	3	one	2
4. picture	wall	3	book	2
5. second	floor	4	hand	2
6. cent	money	1	penny	1
7. neck	tie	1	band	1
8. ascend	staircase	3	upward	2
9. five	cents	1	cents	2
10. hair	brush	3	ribbon	2
11. stair	case	3	way	1
12. knife	pocket	2	cut	3
13. money	count	4	spend	3
14. March	February	3	forward	2
15. times	count	2	present	3
16. change	money	3	loose	2
17. human	race	4	nature	2
18. tie	neck	4	shoe	2
19. floor	second	2	sill	1
20. note	read	3	book	1
Total time		52		36

acts which he had performed, or ones that seemed to bear no relationship whatsoever to the stimulus words. In the case of the Subject whose responses are cited above it will be noted that the responses for the most part are what one would expect because of his behavior, while the responses of the innocent person are the ones which the average person ordinarily would give.

The instructor may devise a similar experiment, or require the students to base their reports upon the above described experiment.

QUESTIONS

1. Briefly describe and compare the responses and reaction times of the two Subjects.
2. How do you explain the lengthened reaction times?

3. What effect does one's environment seem to play in his actions? What implications does this experiment seem to hold for moral training?

4. What is the danger of allowing young children to attend indiscriminately motion-picture performances?

5. How may the teacher aid in correcting the foreign accent of a pupil? And in correcting wrong speech habits, learned in the home, such as, *He ain't, I done it,* etc.

6. Suppose a school allows children to play roughly in the room at recess time. Show how the law of association tends to make the school harder to control during study time in this same room.

7. Most persons naturally talk in a low tone or a whisper in a church, even when worship is not in progress. Explain why?

8. A number drill was being conducted. The teacher gave 9×4. Mary said "36." The teacher then gave 8×7. John hesitated, failed to respond. "John, think!" urged the teacher. Was this good teaching? Is there anything to "think" about in 8×7, or must the association be *immediate* and *automatic*?

9. It was observed that a certain pupil, when he required a number combination, such as 6×9, was obliged to say the whole table up to that point. What was wrong with the method that had given him this type of number associations?

REFERENCES

COLVIN, S. S., *The Learning Process,* Ch. xiii.
SEASHORE, C. E., *Introduction to Psychology,* pp. 159-162.

EXPERIMENT 21

APPERCEPTION: INTERPRETATION OF STIMULI

Object.—*To study the way in which one interprets stimuli.*

Educational treatises of the past have given enthusiastic accounts of the theory of apperception, but present-day educators tend to treat this far-famed theory as part of the psychology of perception and association. If the student will keep in mind his study of perception and association as he reads Professor James'

clear and definite statement of the theory of apperception, he will realize that apperception is nothing but perception and association and that it holds the same relationship to pedagogical methodology as perception and association hold to general psychology.

In his *Talks to Teachers,* Professor James treats the subject admirably:[1] "The gist of the matter is this: every impression that comes in from without, be it a sentence which we hear, an object of vision, or an effluvium which assails our nose, no sooner enters our consciousness than it is drafted off in some determinate direction or other, making connection with the outer materials already there, and finally producing what we call our reaction. The particular connections it strikes into are determined by our past experiences and the 'associations' of the present sort of impression with them. If, for instance, you hear me call out A, B, C, it is ten to one that you will react on the impression by inwardly or outwardly articulating D, E, F. The impression arouses its old associates; they go out to meet it; it is received by them, recognized by the mind as 'the beginning of the alphabet.' It is the fate of every impression thus to fall into a mind preoccupied with memories, ideas, and interests, and by these it is taken in. Educated as we already are, we never get an experience that remains for us completely nondescript; it always *reminds* of something similar in quality, or of some context that might have surrounded it before, and which it now in some way suggests. This mental escort which the mind supplies is drawn, of course, from the mind's ready-made stock. We *conceive* the impression in some definite way. We dispose of it according to our acquired possibilities, be they few or many, in the way of 'ideas.' This way of taking in the object is the process of apperception. The conceptions which meet and assimilate it are called by Herbert the 'apperceiving mass.' . . ."

Material.—Ink and white paper. The rest of the material is to be devised as described below.

Procedure I.—Place one drop of ink on a sheet of paper and press another piece of paper over this drop in order

[1] James, *Talks to Teachers,* pp. 156-157.

to produce an irregular ink blot. On removing the paper quickly look at the irregular ink blot and record the name of the *first* three objects which the blot suggests to you. Do this with two other ink blots.

Present these three ink blots to a classmate and record the names of the objects that the ink blots suggest to him.

QUESTIONS

1. How do you explain that these ink blots suggest real objects?
2. Why do the same stimuli (ink blots) give rise to different interpretations when presented to different people?
3. Does the shape of the ink blot appear to change as new meanings are assigned to it?
4. Why is the analogy between the human eye and the photographic camera likely to be misleading?

Procedure, II.—Do not read ahead, but perform the experiment in the order the directions indicate.

Read the following paragraph:

The music teacher selected "Sweet and Low" for her class to sing. The children apparently enjoyed the selection for they sang it well.

After reading each of the following words immediately write the first word or idea suggested to you by the stimulus word:

scale
note
measure
bar
key

After an interval of about five minutes read the following paragraph:

The science teacher had the pupils review the table of weights and measures in preparation for the experiment which they were to perform. After giving the pupils the necessary material for the experiment, she urged them to observe carefully.

After reading each of the following words, immediately write the first word or idea suggested to you by the stimulus word:

measure
scale
bar
key
note

QUESTIONS

1. Did the same words occurring in different contexts elicit different or similar reactions? How do you explain the particular reactions given in each case?

2. Of what significance is the principle illustrated in this experiment to the teacher who presents a new poem to her children?

3. Illustrate how you would utilize this principle in preparing the pupils for an understanding of the italicized words in the lines given below. Give reasons for the procedure you suggest:

(*a*) The rank is but the *guinea's* stamp.
(*b*) *Charms* strike the sight but merit wins the soul.
(*c*) Full many a flower is born to *blush* unseen.

4. The proper study of many poems and prose selections necessitates an intellectual preparation, that is, a fund of knowledge before the pupil can fully grasp and appreciate the selections. Why? Illustrate.

5. Of what value is an emotional preparation in the teaching of a piece of literature? How can you use pictures, the child's imaginative power, in obtaining the proper emotional feeling for Whittier's "Snowbound," or some poem with which you are familiar?

6. What lessons in history and literature would you plan for the following days: Flag Day, Arbor Day, Lincoln's Birthday, etc.? Why?

7. According to the theory of apperception we learn the new in terms of the old and should therefore teach the new in terms of the old. How would you apply this principle to the teaching

of fractions? The concept of negative and positive numbers in algebra?

8. Professor Starch claims that learning the new in terms of the old has many limitations since most learning involves the establishing of connections between elements which are for the most part new. Appraise this criticism.

REFERENCES

BETTS, G. H., *The Mind and Its Education,* Ch. vii, "Perception"; Ch. x, "Association."

JAMES, William, *Talks to Teachers,* Ch. xiv.

STARCH, Daniel, *Educational Psychology,* pp. 138-140.

EXPERIMENT 22

THE MEMORIZATION OF ROTE AND LOGICAL MATERIAL

Object.—*To compare the efficiency of memory for rote and for logical material.*

The subject for study in the following experiments is not a new one. We have, for example, met memory, in one phase or another, in our study of sensation, habit, perception, imagery, association, etc.[1] It will also be well to keep in mind that the process of memorizing is one sort of learning.

Professor James says that memory is "the knowledge of an event or fact of which in the meantime we have not been thinking, with additional consciousness that we have thought or experienced it before." We usually understand by memory what James's definition implies, of course realizing that an experience is never revived in all of its details and hence memory does not constitute a complete reinstatement of the past.

"Nothing is more obvious than that memory can not return to us what has never been given into its keeping, what has not been retained, or what for any reason cannot be recalled. Further, if the facts given back by memory were not recognized as belonging

[1] The secondary laws of association developed in Experiment 19 may also be considered as laws underlying memory.

to our past, memory would be incomplete. Memory, therefore, involves the following four factors: (1) *registration,* (2) *retention,* (3) *recall,* (4) *recognition.*"[2] The following experiments will, for the most part, deal with these four factors.

Procedure.—Follow all instructions explicitly, and do not read or study any series of numbers or nonsense syllables until definitely directed to do so.

The numbers in Series I are to be learned by reading and rereading the list, *one number at a time,* until just able to recite the list correctly. It is best to uncover one number at a time by sliding a strip of paper slowly to the right and with a second piece of paper covering the digit just to the left of the one uncovered. When able to foretell each number just before it is uncovered then the series may be considered as just learned. Read at the rate of about two digits per second. Keep a record of the number of repetitions necessary to learn the series.

SERIES I

6 4 2 3 9 1 5 7 0 8

The numbers in Series II are to be learned by reading through the series, but this time you are to note the grouping of the numbers. Slide the paper so that the groups marked off by commas can be seen. Record the repetitions necessary to learn the series.

SERIES II

1492, 76, 50, 83

The words in Series III are to be read through but once, at your usual rate of reading. Record the number of words which you are able to reproduce in writing (without reference to the order) immediately after the one reading.

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[2] Betts, *The Mind and Its Education,* Ch. xi.

SERIES III

kind, sell, observe, instead, number, passage, fear, harbor, finished, perception.

The words in Series IV are to be read through but once, at your usual rate of speed. Record the number of words you are able to reproduce in writing (without reference to the order) immediately after the one reading.

SERIES IV

chair, table, cloth, linen, Irish, freedom, slavery, Lincoln, president, secretary.

QUESTIONS

1. Which list of Series I and Series II did you learn better? Of Series III and IV? Why?
2. Why is dull repetition less effective in memorizing than observant study directed toward noting significant facts and relationships?
3. How may the principle illustrated by this experiment be used in teaching the industries of countries? Products? Climate?
4. Why should a rule in grammar never be taught until it has been fully illustrated and comprehended?
5. Most acts of memory depend upon sequence of ideas. Illustrate how this principle may be used correctly and also incorrectly.
6. Give at least three definite classroom applications of the principle under discussion, other than those applications given in your answers to the preceding questions.

REFERENCES

See references at end of Experiment 31.

EXPERIMENT 23

The Value of Recall in Memorizing

Object.—*To determine the effect of recall in memorizing material.*

Material.—Watch with second hand; plain paper (5 × 8 inches), with an aperture sufficiently large to expose one line of the text at a time.

Procedure.—This experiment is to be performed by two students, one acting as Experimenter and the other as Subject. The Experimenter should place the following list of words before the Subject, covering the list with a paper so that the aperture just exposes the words "List A." By sliding this paper downward uncover one word at a time at the rate of one word every two seconds. Be certain that the Subject understands that he is to memorize the words. Go through the list six times in this manner. Distract the Subject's attention for one minute by having him read a book. Then have the Subject write down as many words as he is able to remember, without attention to whether or not they are written in the order in which they were presented. The Subject is thus allowed exactly 300 seconds for the learning of these words (see page 88 for List A).

After the Subject has rested for several minutes, present List B to him in a similar manner, going through the list twice. Then allow the Subject for a period of 100 seconds to think of, that is, *recall,* as many words in the list as possible. Now present the list two more times, and then distract the Subject's attention for one minute. At the end of this minute have him write down as many words as he can remember. Record the number of words remembered. The Subject is thus allowed exactly 300 seconds for the learning of these words (see page 89 for List B).

LIST A

close
mail
help
east
wolf
cabinet
window
head
witness
many
speed
way
bureau
steal
bill
link
work
minds
doctor
weather
sufferer
brother
meadow
vote
race

LIST B

stall
west
capital
new
white
pay
risk
ticket
form
edge
fracture
state
teacher
reason
party
foot
record
office
sister
slow
matter
plan
talk
hour
gold

Questions

1. Compare the number of words remembered in List A and List B. How do you account for the difference?[1]

2. In studying history, it is advisable to stop reading at the end of logical units, and to look away from the book and then mentally *recall* the main ideas just read. When difficulty is experienced in the recall, the passage should be read again. Give two other practical applications of the principle illustrated in this experiment.

References

See references at end of Experiment 31.

EXPERIMENT 24

Distributed Learning and Memory Efficiency

Object.—*To compare the efficiency of distributed and concentrated learning.*

Material.—Same as for Experiment 23.

Procedure.—Present List C to the same Subject used in Experiment 23, going through the list three times. Then distract the Subject's attention for at least 5 minutes, after which present the list two more times and again distract the Subject's attention for 5 minutes. Present the list once more, making a total of six repetitions. Distract the Subject's attention for one minute, at the end of which have him write down as many words as he can remember. Record the number of words remembered.

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[1] The practice gained by learning List A may make the learning of List B easier. To counteract this influence the instructor may, if he considers it necessary, have one part of the class learn List B before learning List A. The securing of the mean number of words for the entire list will then give more accurate results.

LIST C

depend
come
north
early
lawyer
school
money
lesson
column
reader
space
mark
sickness
show
tax
interest
question
case
paper
hole
master
fix
power
boat
road

QUESTIONS

1. Compare the number of words remembered in List C with the number remembered in List A of the previous experiment. What effect does the distribution of repetitions have on the efficiency of memory?

2. What explanation can you give for the greater efficiency for distributed learning than for concentrated learning?

3. Of what significance and value is the principle illustrated in this experiment in one's study? Give a concrete illustration of how you would study a list of spelling words according to this principle.

4. Is drill in mental arithmetic more effective when the time allotted to it each week is distributed over short periods throughout the week instead of being concentrated in one period? Why?

5. In the light of the principle illustrated in this experiment, why is "cramming" ineffective as a permanent and efficient learning method?

REFERENCES

See references at end of Experiment 31.

EXPERIMENT 25

THE PART AND WHOLE METHOD OF MEMORIZING

Object.—*To compare the relative value of the part method and of the whole method in memorizing.*

Procedure, I.—This experiment may be performed by each student individually. Do not study the following two stanzas until instructed to do so. Each stanza contains four lines. Take the first stanza and learn it by repeating each line six times, that is, repeat the first line six times, then the second line six times, etc. After repeating the last line six times, put the book aside and try to write the entire stanza or any line of it you can. In repeating the lines do not take an undue amount of time but read somewhat slower than you ordinarily do.

STANZA I[1]

Go paint the birch's silver rind,
  And quilt the peach with softer down;
Up with the willow's trailing threads,
  Off with the sunflower's radiant crown![2]

Procedure, II.—Take the second stanza and read it from beginning to end in an attempt to get its meaning and also to remember it. Reread the stanza five more times from beginning to end, trying to learn it. After the last repetition, put the book aside and try to write the entire stanza or any line of it that you can. In repeating the stanza do not take an undue amount of time, but read somewhat slower than you ordinarily do.[3]

STANZA II

Go plant the lily on the shore,
  And set the rose among the waves,
And bid the tropic bud unbind
  Its silken zone in arctic caves.[2]

QUESTIONS

1. Without attention to their proper order, how many lines are you able to recite correctly by the part method? By the whole method? How do these two methods compare when their efficiency is judged by the order in which the lines are produced?

2. Do all the members of your class find one of the two methods the better, or do there appear to be some who learn better by one method and the rest by the other method? (Examine the findings of several of your classmates in order to answer this question.)

3. Suppose you had several hundred lines instead of four to memorize, what modification of the whole method would you suggest if you were going to follow this method? Why?

[1] If the Subject is familiar with the passages used, others will need to be substituted.

[2] Selections from "The Meeting of the Dryads" by Oliver Wendell Holmes.

[3] See footnote on p. 90.

4. A pupil recites the first stanza of a poem correctly, then hesitates as if unable to go on; in a desperate attempt to recall the first line of the second stanza he again recites the first stanza but still finds himself unable to recall the second stanza. Finally, he starts to recite the third stanza. What may be the possible explanation for his inability to recall the second stanza? In what way does the "whole" method of study tend to prevent such errors?

5. How may we apply the whole method to our reading of history, geography, etc.?

6. What explanation can you give for the greater efficiency of one method over the other? The performance of Experiment 27 will aid in answering this question.

7. Let each member of the class work out one definite application of this principle to classroom instruction. Compare results and criticize.

REFERENCES

See references at end of Experiment 31.

EXPERIMENT 26

PURPOSE AND INTEREST IN LEARNING

Object.—*To determine the effect of intentional learning and interest upon memory.*

Material.—Watch with second hand.

Procedure, I.—This experiment is to be performed by two students, one to act as Experimenter, the other as Subject. The Subject should not be made familiar with all of the instructions, but should simply do as he is directed. Present the following figures in List I to the Subject with the directions that he is to read them silently, from beginning to end, as fast as he can. Furthermore, tell him that you are interested to learn how many times he can say these numbers in three minutes, so that every time he completes one repetition of the entire group he

is to tap with his pencil. Keep a record of the number of repetitions.

LIST I

4	1	8	9	0	2	5	6	3	7
3	2	0	4	1	5	7	9	6	8
8	5	9	3	2	4	1	0	7	6
0	4	7	8	5	9	6	2	1	3
9	3	6	7	4	8	0	1	2	5

Immediately after the Subject has completed a three minute repetition of the numbers, direct him to write as many of them, in their proper order, as he can.

Procedure, II.—Present the following group of figures to the Subject, and tell him that he is to learn as many of the figures as he can in three minutes.

LIST II

5	1	6	8	4	9	2	3	7	0
7	8	0	5	1	3	4	2	6	9
3	5	9	7	8	4	6	1	0	2
2	7	3	9	6	5	0	8	1	4
4	2	5	3	0	1	7	9	8	6

Immediately after the Subject has studied the figures in List II for three minutes, direct him to write as many of them, in their proper order, as he can.

QUESTIONS

1. Comment upon the following statement: Interest insures an active attitude toward the material which is being learned.

2. How does intentional learning compare with mere mechanical repetition, when judged by the immediate memory for the material? How do you explain the difference?

3. Illustrate the significance of the principle of intentional learning in directing the study of children. Why is homework often of little value?

4. What danger must the teacher guard against in formal drill in such subjects as arithmetic and grammar? Why is concert recitation often of little value?

5. Comment upon the following statement: "Practically all that the child learns in the first few years of his life, he learns without any 'will to learn.'" (Woodworth.)

6. Why in studying such a subject as history is it advisable to outline the book, or mark the points in the book you desire to remember?

7. Why do we often question the reliability of testimony of eye witnesses?

8. James was taking eighth-grade manual training work. He approached the instructor with the request to be allowed to make a rather pretentious table for his own room at home. The instructor said, "But you would first have to be able to draw the model to scale, and to compute the materials required. And you know you are not good in drawing or arithmetic and do not study these subjects hard." James insisted, "But if I learn to figure and draw?" "Then you may go ahead," said the teacher. James was soon leading his class in drawing and arithmetic, and continued to do so even after he had the table made. Explain the principle involved and its application.

References

See references at end of Experiment 31.

EXPERIMENT 27

Influence of Formation of Associations upon Memory

Object.—*To study the influence of the formation of associations upon memory.*

Perhaps you have met the pupil who is able to recite the multiplication tables accurately and quickly, but is unable to use these

combinations in simple multiplication examples. The writer has met a feeble-minded boy who was able to recite several chapters of a history book dealing with the Civil War, but was unable, when asked, to tell one thing about Lincoln. As far as multiplication tables and the history material are concerned, the pupil and the feeble-minded boy might as well have learned a group of nonsense syllables for all the use the material is going to be to them.

In memorizing material we must be certain that we form our associations in the order in which we are going to use them, and that we learn to generalize our knowledge so that we can use it when a different combination of conditions, other than those under which we first learned the material, call for it.

Material.—Watch with second hand.

Procedure.—This experiment is to be performed by two students, one to act as Experimenter and the other as Subject. Without reading further, let the Experimenter make two lists of the following letters in his notebook; place each letter upon a separate line.

E Q J B Y G S D P W T K F C N R V M H U O X I L

Present one list of these letters to the Subject and instruct him to write after each letter just as quickly as he can the letter which immediately follows it in the alphabet. Take the time in seconds necessary to do this, and record the number of errors, if any are made. Then present the second list to the Subject, and have him write after each letter, just as quickly as he can, the letter which comes just before it in the alphabet. Take the time necessary to do this, and record the number of errors, if any are made. Do not permit the Subject to figure out the letters on paper; this must be done mentally.

Questions

1. Compare the accuracy and rapidity of completing List I and List II. How do you explain the differences?
2. Why do pupils often fail to spell words correctly in sentences although these same words are spelled correctly when given separately in a test?
3. Indicate several methods you should follow in teaching the multiplication tables in order to insure the use of the combinations under conditions other than those called for when the tables were first learned.
4. Why are questions in history, geography, etc., requiring interpretation and comparison, more valuable than those requiring a mere recital of the facts learned from a book?
5. Why is it wrong for the language teacher to emphasize in class the formation of a Latin-English vocabulary and then examine the class in an English-Latin vocabulary?
6. Why are some people able to understand or read a foreign language, but unable to speak it?
7. Summarize the experiment by commenting upon the statement: Form associations in the order in which they are to be reproduced or used.

References

See references at end of Experiment 31.

EXPERIMENT 28

Retention and Forgetting

Object.—*To study the meaning and significance of retention.*

Retention implies a state of rest during which the learned material is not in the field of consciousness, and after which it appears in the field of consciousness when the proper situation recalls it. This statement is not to be interpreted to mean that we carry around with us the names of our friends, but rather that we possess the machinery for producing the names when the

proper stimulus is present. This machinery is the various brain connections.

Just as the fully developed muscle tends to atrophy when exercise is discontinued, so the machinery which makes possible retention tends to atrophy if not used. The ability or inability with which we are able to retain material varies considerably. Some material, such as the names of our immediate friends, is overlearned to such an extent that we are unlikely to forget it. But the poem, learned when we were in elementary school, unless it aroused within us great interest or often has been repeated by us, may defy our attempts to recall it completely. We may be able to reproduce a word or a line of it; that is, retention may vary from 0 to 100 per cent. When one does not need to repeat a poem in his attempt to relearn it, the retention for that poem may be considered as 100 per cent. If the poem originally required 30 minutes to learn, and if, after an interval, just 15 minutes are necessary to relearn the poem, then we may say that the retention was approximately 50 per cent. The saving, whether it be in repetitions or time, is the measure of retention. It is often surprising to discover how quickly we can relearn the poems of our childhood which we believed to be forgotten completely. Strictly speaking, we have not only obtained by this method an indirect measure of retention but also an indirect measure of forgetting.

Material.—Watch with second hand; plain white paper, 5 x 8 inches, with aperture sufficiently large to expose one complete line of the book and at the same time to cover the remaining lines upon the page.

Procedure, I.—You are to learn the following stanza by the whole method. Follow all instructions explicitly. Arrange the paper with the aperture so that the word "Stanza" is uncovered. Now note and record the position of the minute and second hands; immediately begin to slide the paper down so that the first line of the stanza is exposed. Read this line with the intention of learning it. As soon as you complete the one reading, slide the paper down

so that the next line is exposed, and so on. When you have studied all of the lines once, that is, repeated the poem from beginning to end, go through the poem again. This time, however, attempt to recall each line just before you expose it. Continue to go through the stanza until you are just able to foretell each line, that is, until you have just learned the stanza. Note and record the time in seconds necessary to just learn the poem.

STANZA

TO-MORROW [1]

Where art thou, beloved To-morrow?
When young and old and strong and weak,
Rich and poor, thro' joy and sorrow,
Thy sweet smiles we ever seek,—
In thy place ah! well a-day!
We find the thing we fled To-day.

Do not read *further* than this paragraph, but on the following day, or, if possible, after an interval of a week, read **Procedure, II,** and perform the experiment as directed. In the meantime, do not think of the stanza you have just learned.

Procedure, II.—This part of the experiment is to be performed 24 hours or more after **I.** Place the paper with the aperture over the stanza *just learned* according to the instructions set forth in **I.** Note and record the position of the minute and second hands. Before uncovering the first line try to recall it. If unable to do so, uncover it. Then try to recall the second line, etc. Go through the stanza until you are again just able to recite it. Note and record the time necessary to relearn the stanza.

QUESTIONS

1. Was there a saving of time in relearning the stanza? How great a saving?

[1] Shelley.

2. What light does this principle throw upon drill and review in school work. Why is it advisable to overlearn material we wish to remember?

3. Why would it be a disadvantage to be able to remember everything once experienced, and not be able to forget?

REFERENCES

See references at end of Experiment 31.

EXPERIMENT 29

THE INFLUENCE OF RETROACTIVE INHIBITION UPON MEMORY

Object.—*To determine whether or not the formation of a set of associations weaken the permanency of associations previously formed.*

Studies in experimental psychology have indicated that the bonds of association formed in learning material are often weakened and inhibited by crowding the learning of new material too closely upon formation of these bonds of association. This phenomenon is known as *retroactive inhibition.*

Material.—Plain white paper, 5 x 5 inches, with aperture in center sufficiently large to expose six letters, and at the same time to cover the lines immediately preceding and following these letters.

Procedure, I.—You are to learn the following nonsense syllables by the whole method. Follow all instructions explicitly. Arrange the paper with the aperture so that the first nonsense syllable is uncovered. Read this syllable once with the intention of learning it. Then slide the paper down so that the next syllable is uncovered, and read this once with the intention of learning it. Continue to do this until you have read each of the ten nonsense syllables once. When you have studied all of the nonsense syllables once, go through the list again, but this time attempt to

recall each syllable just before you expose it. Continue to go through the list in this manner until you are just able to foretell each syllable, that is, until you have just learned the list. Note and record the number of repetitions necessary to just learn the list. After learning the list, follow the instructions which are given below the list.

LIST A

kob
taf
gid
cel
fuj
mar
vix
don
zup
tes

Turn to the preface of this book and read it silently at your usual rate of speed, without thought of the list of nonsense syllables you have just learned.

After reading the preface again, relearn the nonsense syllables in List A in the manner described above. Note and record the number of repetitions necessary to relearn the material.

Procedure, II.—After an interval of ten minutes learn the nonsense syllables in List B in the same manner followed in learning the syllables in List A. Keep a record of the number of repetitions necessary to learn this list.

Now let your mind lie fallow for five minutes, that is, do no work requiring intensive thought. Do not think of the syllables you have just learned. After this interval of five minutes, relearn the syllables in List B, and record the number of repetitions necessary to relearn the list.

LIST B

lup
sem
nav
rok
wis
bop
gan
heb
cuf
dil

QUESTIONS

1. Find the percentage of repetitions necessary to relearn List A. To relearn List B. What effect did the reading of material have upon the permanency of the memory for the syllables in List A? Effect of the period of rest upon the permanency of the memory for the syllables of List B?

2. On the basis of your experiment and reading explain what retroactive inhibition is. What explanation do you suggest for this inhibition?

3. Why is it advisable to follow intensive school work with periods of rest, light setting-up exercises, etc.?

4. Give evidences drawn from your own experience or that of others where periods of rest, such as a night's sleep, have been followed by an increased ability to reproduce material which previous to the rest was recalled with difficulty.

5. In the light of this experiment indicate the value of the departmental system of class organization in which the pupils pass from one room to another to take up a new subject.

REFERENCES

See references at end of Experiment 31.

EXPERIMENT 30

Recall: A Factor in Memory

Object.—*To determine the general nature of recall, a factor in memory.*

"Recall depends entirely upon association. There is no way to arrive at a certain fact or name that is eluding us except by means of some other facts, names, or what-not so related to the missing term as to be able to bring it into the fold. Memory arrives at any desired fact only over a bridge of associations. It therefore follows that the more associations set up between the fact to be remembered and related facts already in the mind, the more certain the recall." [1]

There are a few cases where recall seems to recur without a stimulus. A tune, for example, seems to appear suddenly and keeps running through our heads, or, as we lie abed, scenes of the day flash through our minds. This phenomenon is referred to as *perseveration.* It may be that some vague stimulus actually arouses these associations; the recency of the events or their familiarity make necessary only a faint stimulus to bring them into memory. A soldier who had passed through the World War complained that without apparent cause scenes he had witnessed in France would flash through his mind. Investigation revealed that these associations were aroused on cold, wet mornings—just the sort of mornings the soldier had often experienced when in action. This situation probably comprised the vague stimulus necessary to recall the associations.

Recall being less under our control than registration and memorizing, we cannot expect to study it adequately in the classroom. We must introspect and review the difficulties experienced in recall, and also study our successful achievements in recall. This will then enable us to formulate aids for recalling data.

Procedure.—*A.* Why are you unable to recall a list of

[1] Betts, *The Mind and Its Education,* Ch. xi.

nonsense syllables several weeks after you have succeeded in just learning them?

B. Write the first half dozen lines of some poem which you know well. By introspection note and record the way in which you recall each line.

C. Recall some recent picnic or party that you attended. What sort of weather did you enjoy? How are you certain that this recall is correct?

D. In your study of history how do you tell approximately when certain events occurred, for example, the Dred Scott case?

E. When one forgets the name of an acquaintance, why is the following procedure often followed in attempting to recall the name?

(1) Reciting the alphabet slowly
(2) Thinking of the first time the person was met
(3) Looking squarely at the person and avoiding doubt as to the ability to recall the name, etc.

F. Why does a teacher, who is able to name all the pupils in her class, frequently fail to recall their names when she meets them on the street?

G. Why does a speaker often forget and stumble in his talk? What inhibits and interferes with his thoughts? What suggestions and advice would you give to a person about to speak in public?

H. Why is it advisable to discontinue for a short interval your work in such a subject as mathematics, or the translation of French, when you strike a difficulty which confuses and defies solution? The performance of Experiment 29 may throw some light upon the solution of this question.

General Question

On the basis of your experience and the answers to the above questions construct a list of suggestions for aiding recall.

REFERENCES

See references at end of Experiment 31.

EXPERIMENT 31

RECOGNITION: A FACTOR IN MEMORY

Object.—*To determine the general nature of recognition, a factor in memory.*

Professor Colvin says that to "recognize an object merely implies that we react to it with a degree of familiarity, but it does not imply that we recall definitely where we have previously had experience with this object." We are all aware of the fact that we recognize the meaning of words which we would be unable to recall for use in our speaking vocabulary. The baby appears to recognize before he gives evidences of recall. Therefore the theories of recognition can not depend entirely upon recall. Recognition implies, then, the reaction toward an object of past experience and a feeling of familiarity which could not occur the first time the object was experienced.

Material.—One hundred different pictures of uniform size, or 100 one-page advertisements of uniform size.

Procedure.—The Instructor will act as Experimenter and the students as Subjects. Select 20 pictures at random from the 100. Divide the remaining 80 pictures into two even piles of 40 each. Letter the 20 test pictures on the back so that they can be located accurately. Shuffle the 20 pictures into one of the piles.

Instruct the students that you are going to expose 60 pictures for an interval of two seconds each and that they are to study these pictures so that they will be able to recognize them should they see them again. After presenting the 60 pictures quickly, pick out the 20 test pictures and shuffle them into the second pile. Then instruct the students that you are going to expose some more pictures,

among which will occur some of the pictures previously shown and that when they recognize a picture they are to place the number of that picture upon a piece of paper. As you present each picture, assign a serial number to it. After the 60 exposures obtain the numbers of the 20 test pictures. Warn the students not to be influenced by the actions of their classmates.

Allow the class 10 minutes in which to recall and record upon paper the pictures presented twice. Keep all pictures concealed during this period. The record may simply consist of any distinguishing feature in the picture, name of the article advertised, etc.

Arrange the test pictures so that they can be seen by the class. Let each student, on the basis of the experiment, answer the following questions:

Questions

1. (*a*) What percentage of the pictures did you *recognize* correctly? (*b*) Percentage incorrectly recorded as *recognized?* (*c*) Percentage correctly *recalled?*

2. How did you know that you had seen the pictures before? What caused you to be in error in some of your beliefs?

3. Were you able to recognize some pictures that you were not able to recall?

General Questions

1. Professor Colvin gives the following as a general rule for economical learning:[1]

> Select material of reasonable length for one period of study; go over it carefully and slowly for purposes of orientation; repeat this until the general nature of the material is clearly understood, then increase the tempo. Continue to learn by the whole method until the majority of the material is raised above the threshold of memory. Next, strengthen the weak associations (i.e. those not raised above the threshold of memory); then go over the whole again until it

[1] From Colvin, *The Learning Process*, pp. 174, 175. Copyright by the Macmillan Co. Reprinted by permission.

is fixed. It is desirable to raise all the elements considerably beyond the threshold of memory. During the learning period practice recall; also, allow several minutes after the actual learning is finished for recalling and fixing the associations already formed. This will be found to be one of the most important methods of firmly establishing the material in memory. Relearn the material on several succeeding days until it is thoroughly mastered.

In the light of the experiments performed in your investigation of memory interpret the meaning of Professor Colvin's general rule for learning. In your interpretation emphasize the practical school applications of the principles to which he refers.

REFERENCES

BETTS, G. H., *The Mind and Its Education,* Ch. xi.
AVERILL, E. A., *Psychology for Normal Schools,* Lesson 37.
CAMERON, E. H., *Psychology and the School,* Ch. vi.
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COLVIN, S. S., *The Learning Process,* Chs. ix, xi, xii.
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LA RUE, D. W., *Psychology for Teachers,* Ch. ix.
NORSWORTHY and WHITLEY, *Psychology of Childhood,* Ch. viii.
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EXPERIMENT 32

CONCEPTION AND JUDGMENT

Object.—*To study the processes of conception and judgment.*

"All true thinking is for the purpose of discovering relations between things we think about. Imagine a world in which nothing is related to anything else; in which every object perceived, remembered, or imagined, stands absolutely by itself, independent and self-sufficient. What a chaos it would be! We might perceive, remember and imagine all the various objects we please, but without the power to think them together, they would all be

totally unrelated, and hence have no meaning."[1] Meaning depends upon relations, and the function of thinking is to discover relations.

The word *thinking* is usually understood to cover the three processes of (1) conception, (2) judgment, and (3) reasoning. It is also used frequently to refer solely to the reasoning process.

Procedure, I.—Write a definition of *table.* By introspection, or otherwise, note the mental processes involved in the writing of the definition. Make certain that your definition includes and covers all tables, but includes or covers nothing but tables. If you actually have met the requirements of the above definition, you have formulated a *concept.*

QUESTIONS

1. Did your mind go through the following steps: (*a*) assembling the data; (*b*) abstracting the characteristics always present in a *table;* (*c*) generalizing on the basis of your abstraction. If your mind passed through these steps or other steps, briefly describe them.

2. How do you suppose the very young child forms a concept of a *cat?* Does a concept remain stationary after it has been formed, or does it continue to grow throughout life?

3. Try to recall different stages in the development of some concept in your own experience, as of *clouds, lions, mountains, God.* Are your concepts still undergoing reconstruction? What ones have changed most this year?

4. Why do many people incorrectly call a *whale* a *fish?* Children incorrectly apply the term *circle* to a *ball, coin,* etc.? Give two additional illustrations of incorrect concepts commonly held by children.

5. The teacher often uses carelessly such terms as *bad boy* so that the child concludes that after all there is nothing so terrible in being a *bad boy.* Give two other illustrations of the careless use of concepts by teachers.

[1] Betts, *The Mind and Its Education,* Ch. xii.

6. How may the school contribute to the formation of correct concepts? Illustrate with the concepts *mountain, peninsula, absolute monarchy.*

7. What part do sensations, perceptions, and images play in the concept?

8. Give your own definition of a concept.

In the building up of percepts and concepts, and also in using them, another process of thinking enters—the process of *judging.* Perception, conception, and judgment are not actually separated from one another in the thought process. "They are rather but different *stages* in the same general process. Perception gives us *individual objects* or object groups present to the senses; conception gives the *general idea* or meaning of a related class of objects; judgment *analyzes the situation and relates it* to the concept to which it belongs and so supplies the cue for response or behavior."

Procedure, II.—In complying with the following directions, note the stages in the mental processes, evident when solving the problem set by the instructions.

Instructions.—Three or more answers follow each of the incomplete statements given below. You are to look at the answers carefully, then decide which is the correct one.

1. An apple is
   - (*a*) a kind of tree.
   - (*b*) a kind of plant.
   - (*c*) a kind of fruit.

2. A mimeograph is
   - (*d*) a kind of adding machine.
   - (*e*) a kind of copying machine.
   - (*f*) a kind of typewriter.

3. An eight-sided figure is
   - (*g*) called a pentagon.
   - (*h*) called a triangle.
   - (*i*) called an octagon.
   - (*j*) called a trapezium.

4. Spawn is a term used most frequently

(*k*) in the field of pedagogy.
(*l*) in the field of biology.
(*m*) in the field of law.
(*n*) in the field of theology.

Questions

1. In the light of the experiment comment upon the following quotation: The process of judging[2] usually displays the following stages: "(1) a controversy, consisting of opposite claims regarding the same objective situation; (2) a process of defining and elaborating these claims and of sifting the facts adduced to support them; (3) a final decision, or sentence, closing the particular matter in dispute and also serving as a rule or principle for deciding future cases." (Dewey)

2. The more important sources of error in judgment are: (1) faulty or inadequate perception; (2) improper or wrong memory; (3) faulty elimination; (4) faulty generalization; (5) careless use of ambiguous language. Give illustrations of three faulty judgments and indicate wherein the errors lie.

3. Give in your own words a definition of *judgment.*

References

Betts, G. H., *The Mind and Its Education,* pp. 184-200.

See also references at the end of Experiment 34.

EXPERIMENT 33

Learning Through Trial and Error

Object.—*To determine the manner in which a mechanical puzzle or similar problem is solved.*

Material.—Watch with second hand; four mechanical puzzles; coördinate paper.

[2] In the formation of a simple judgment the answer is known in a flash or is not known. There is so short a moment of judging that it is difficult to introspect.

Procedure.—This experiment is to be performed by two students, one to act as Subject and the other as Experimenter. Let the Experimenter first learn how to solve one of the puzzles and how to put it together. Let the Experimenter then present the puzzle (with which the Subject must be unfamiliar), requesting him to solve it. Keep a record of the time in seconds necessary to solve the puzzle; note the Subject's behavior, whether or not he works with a plan or proceeds in a hit-and-miss fashion, etc. When the puzzle has been solved, put it together again without the Subject seeing you do it. Let the Subject solve the puzzle at *least* fifteen times, or until he solves it quickly. Keep a record of the time necessary for each solution.

After the last trial ask the Subject to introspect, and tell you how he solved the problem.

Now let the Subject act as Experimenter and present a new puzzle as described above to the student who first acted as Experimenter.

If either of the two puzzles was solved quickly so that the time necessary to complete the solution for the first few trials varied little, use one of the other puzzles.

Questions

1. Let each Experimenter represent graphically the time necessary for each trial. Let the x-axis represent the various trials and the y-axis the time necessary to solve each trial.

2. What is the general shape of the curve? Compare this curve with the curve obtained in the experiment on habit formation (Experiment 8).

3. On the basis of the introspections, the observations of objective behavior, and a study of the graphs, write a brief account of the manner in which the puzzles were solved.

4. Observe a young child learning to copy a short sentence with a pencil. What are the chief characteristics of this sort of learning?

5. (*a*) To learn by trial and error is often wasteful and in-

efficient. Why? (*b*) How would you limit trial and error in the learning of handwriting, drawing of common objects, a laboratory exercise in general science?

6. Give several illustrations of the way in which your own learning has been of an exploratory nature.

REFERENCES

AVERILL, L. A., *Elements of Educational Psychology,* Lesson 6.
RUGER, H. A., "Psychology of Efficiency," *Archives of Psychology,* No. 15, pp. 1-39.
STARCH, Daniel, *Educational Psychology,* pp. 141-153.

EXPERIMENT 34

REASONING

Object.—*To become acquainted with the general nature of the reasoning process.*

Material.—Watch with second hand.

Procedure, I.—In complying with the following instructions, note by introspection, and otherwise, your method of attacking and solving the problem set by these instructions. The groups of letters that follow do not form good English words, but if the letters are rearranged they do form good English words. The order of rearrangement is exactly the same for each group. Rearrange these letters so that they make words, and keep a record of the time necessary to do this. Do not spend more than five minutes upon the solution of the entire problem.

gnikniht
egagne
geb
tcaf
tilps
yrassecen

QUESTION

Write a brief account of your method of attack and of your solution of the above problem. Give the number of words correctly worked out or an account of your inability to solve the problem, etc. (Do not read further until you have complied with the above instructions.)

Procedure, II.—In solving the above problem you were left to your own ingenuity. A knowledge of the various steps usually present in the completed reasoning process may aid you in a more rapid and a more accurate solution, and also serve to give you a better insight into the reasoning process.

In solving the problem set for you in **I** you first ought to have recognized the difficulty, that is, your thought ought to have been challenged. Secondly, but in its practical workings simultaneously with the above step, you ought to have made certain that you fully comprehended the nature of the problem to be solved. Thirdly, you ought, through analysis and synthesis, to have considered possible solutions. Fourthly, you should have tested the validity of the implications of the possible solution you selected as the best one. Fifthly, you should have continued the testing of the validity and through further observation and experiment accepted or rejected your hypothesis.[1]

Let us illustrate these five steps which are usually evident in the completed reasoning process. The difficulty becomes a felt one because we realize that our present knowledge as now organized does not enable us to read *gnikniht,* etc. After fully recognizing what is expected of us, we begin to seek for clues. The smallest combination of letters *gcb,* according to definition, represents a word, and all other combinations are arranged in like manner.

[1] For additional discussion of the reasoning process see Dewey, *How We Think,* Ch. vii; Betts, *The Mind and Its Education,* Ch. xii.

Hence the solution of this one word may give us the key to the general solution. The only possible combinations of *geb* are: bge, ebg, egb, gbe, and *beg,* which is the only combination making a good English word. What is the arrangement of the letters in *geb?* The letters are placed backwards, etc. Let us now test this hypothesis and we find that it works in every case.

With the above suggestions in mind rearrange the following groups of letters so that they make good English words. All of the letters in each group are arranged according to the same principle. Be prepared to report on your method of attack, etc., and do not use more than five minutes for the entire solution.

htsi
aftc
ebofer
rtiaingn
ytep
ispmelts

QUESTIONS

1. Write a brief account of the method followed in solving the above problem.

2. To what extent did trial and error appear in the solution of the problem in **I**? In **II**?

3. To what extent was your reasoning "an exploratory process, a searching for facts"?

4. Of what aid, if any, was the idea of the general knowledge of the steps involved in reasoning to you in solving the problem in **II**? What effect did the similarity of the two problems play in the solution of the last one?

5. Of what value do you suppose the knowledge of the steps involved in reasoning would be to a relatively unrelated problem? Answer this question by solving the following problem in arithmetic: A certain division contains 6,000 artillery, 15,000 infantry, and 1,000 cavalry. If each branch is expanded proportionately

until there are in all 24,200, how many will be added to the artillery?

6. Suggest thought problems that are so simple that the pupil is not conscious of taking the five steps.

7. Suggest thought problems for the following school subjects: geography, history, civics, and English.

8. Can we teach children to reason? If so, how?

9. A commission for the study of mathematics teaching in public schools asked sixth-grade pupils this question: "If a duck which is standing on one foot weighs 3 pounds, what would it weigh if it were standing on its two feet?" About half the children answered that it would weigh 6 pounds. Explain where the fault in teaching had been and how it might be corrected.

References

Betts, G. H., *The Mind and Its Education,* Ch. xii, especially pp. 200-208.
Averill, E. A., *Psychology for Normal Schools,* Lesson 38.
Cameron, E. H., *Psychology and the School,* Ch. viii.
Colvin and Bagley, *Human Behavior,* Ch. xviii.
Colvin, S. S., *The Learning Process,* Chs. xx, xxi, xxii.
Dewey, John, *How We Think.*
La Rue, D. W., *Psychology for Teachers,* Ch. xii.
Norsworthy and Whitley, *Psychology of Childhood,* Ch. x.
Woodworth, R. S., *Psychology,* Ch. xviii.

EXPERIMENT 35

Induction and Deduction

Object.—*To study induction and deduction.*

Procedure, I.—In complying with the following instructions and in attempting to solve the problems, note by introspection and otherwise your method of attack and solution. Be prepared to indicate the differences and likenesses between your methods of solving the two problems,

GROUP I

MPC
3

NPH
8

SMD
4

RTL
12

YXA
1

QUG
7

RTE
5

ZWI
9

NOB
2

VYK
11

YXF
6

TUJ
10

given in **I** and **II**, and between the problems, given in **III** and **IV**.

While reading these instructions keep Group I covered with a piece of paper. You are to slide the paper down slowly so that it exposes one series of letters, then the number just below the series of letters, etc. Try to predict on the basis of the letters the order in which the numbers appear, that is, try to discover the law or rule governing the appearance of the numbers. Go through the series until you are able to state the rule.

Procedure, II.—Cover Group II with a piece of paper and as you uncover each series, on the basis of the rule you have just devised, attempt to fill in the letter which should come just before the number.

GROUP II

YX—, 6

NR—, 11

ON—, 3

WV—, 8

YX—, 1

Procedure, III.—What tentative conclusion can you draw from the following data?

"Lightning travels in a zigzag line, and so does an electric spark; electricity sets things on fire, so does lightning; electricity melts metals, so does lightning. Animals can be killed by both, and both cause blindness. Pointed bodies attract the electric spark, and in the same way lightning strikes spires, and trees, and mountain tops."[1]

Procedure, IV.—What two conclusions can you draw from the following statements?

[1] From A. B. Buckley, *A Short History of Natural Science.*

The "donors gave the property to the institution with a distinct and unanimous understanding as to its future use. The directors who acted for the institution in this transfer must necessarily have had an understanding, either the same as that of the donors, or different."[2] If the understanding of the directors was the same as that of the donors, what were the directors obligated to do? If the understanding of the directors was different from the understanding of the donors what were the directors obligated to do with the property?

Questions

1. Briefly indicate by introspection, and otherwise, your methods of solving the problems given in **I** and **III**. In **II** and **IV**.

2. What likenesses and differences exist in the *mental processes* involved in these two methods, which are known respectively as *induction* and *deduction*?

3. What are the likenesses and differences of these methods when judged solely on the basis of objective procedure, with no reference to the thought processes?

4. On the basis of your answers to the three previous questions indicate differences between psychology and logic.

5. Take the series YXA, 1 and YXF, 6. Suppose 1 represents a group of people who give no evidence of a fever, 6 represents a group who give evidence of a fever, furthermore that YX represents the food eaten by all of the people concerned, and that A represents the source from which one group of people obtain their milk, and F represents the source from which the other people obtain their milk. What can you then conclude about the probable cause of the fever? Why?

6. Give an illustration in the field of science where control or prediction are possible as a result of thinking.

7. Give any evidence drawn from your own studies where prediction or control was wrong. What caused the error? How would you proceed to prevent the recurrence of such an error?

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[2] From Creighton, *An Introductory Logic*. Copyright by the Macmillan Co. Reprinted by permission.

8. Briefly describe some phase of a school subject which could be taught: (*a*) inductively; (*b*) deductively; and (*c*) by a combination of these two methods.

9. Make a definite outline of a lesson plan for presenting inductively some topic in elementary arithmetic; geography; civics; hygiene.

10. Explain the process of thinking by analogy. Show how you would teach your pupils by analogy electricity, the effects of heavy rain and the consequent overflowing of a river, or some similar topic.

11. Explain and illustrate from school practice the statements: (*a*) General truths to be of permanent value must be earned. (*b*) Proceed from the known to the unknown. (*c*) Proceed from the particular to the general. (*d*) Proceed from the simple to the more complex.

REFERENCES

See references at end of Experiment 34.

EXPERIMENT 36

INSTINCTIVE TENDENCIES

Object.—*To study the general nature of instinctive tendencies.*

"By *instincts* are meant certain inborn tendencies to motor responses of characteristic types. As a more formal definition we may say that *instincts are the tendency to act in certain definite ways without previous training and without a conscious end in view.* The child is born ignorant and helpless. It has no memory, no reason, no experience of any sort. It has never performed a conscious act and does not know how to begin. It must get started with certain necessary motor responses, but how? It is at this point that instinct begins to function. A part of the child's native equipment is a nervous system pre-organized to act in a characteristic way in the presence of certain stimuli: the lips are touched and nursing begins; pain or discomfort comes and a cry is the response. Instinctive acts in either animals or men do not

require previous training; the baby does not have to be taught to suck or the duck to swim. There is *no* conscious end in view when the act is first performed, though the result itself may be highly desirable."[1]

Our reactions are often the result of the combination of a native and a learned reaction. For example, a person meets us and extends his hand to shake hands. It is almost impossible to keep from offering our own hand. The native reaction dictates a social response, the learned action dictates the hand shake.

The experimental study of the native equipment of man and animals is still in its beginnings. The majority of experiments so far performed have been upon animals.[2] Observation of behavior and the analysis of this behavior still form the most fertile methods for studying this phase of psychology.

Procedure, I.—The Observer is to visit the nursery, the playground, the street, the classroom, or wherever he can come in contact with children. He is to observe the behavior of the children and attempt to determine the part of their behavior which is learned and the part which exists apart from learning, that is, the behavior which is native and unlearned.

To systematize this observation the following outline is suggested:[3] In each of the following reactions decide on the basis of your own observation whether the connection of stimuli and responses is probably native or learned. Be prepared to give reasons for your analyses.

Stimulus	*Response*
1. a sudden noise	.....starting
2. a highly colored object	.attending to it
3. a bright light	.....blinking

[1] Betts, *The Mind and Its Education*, Ch. xiii.

[2] For a review of such experiments see Watson, *Behavior, An Introduction to Comparative Psychology* and *Psychology from the Standpoint of a Behaviorist.*

[3] Partly adapted from Woodworth, *Psychology, A Study of Mental Life*, p. 103.

Stimulus	*Response*
4. a bright light	shading the eyes
5. sight of a ball	reaching for it
6. ball in the hand	throwing it away
7. a moving object	turning to look at it
8. an insulting remark	anger
9. an insulting remark	requesting an apology
10. cold	putting on coat
11. cold	shivering
12. food	eating it
13. food	cooking it
14. a barking dog	running away
15. possession of a new dress	displaying it

Continue this general analysis by adding similar observations of your own.

Procedure, II.—On the basis of your observation, study the traits and actions which are given below and indicate, with reasons, the ones which you believe are, for the most part, due to training or due to heredity.

Look for evidences of and study these traits and actions: to fear, to study, to be active physically, to imitate, to play, to read, to be curious, to tease, to manipulate, to destroy, to construct things, to obey, to be active mentally, to be bashful or shy, to be sympathetic, to compete with others, to envy, to fight, to tell a falsehood, to tell the truth, to desire praise and social approval, to collect things, to associate with others, to be alone, to be stubborn, to be submissive, to show off, to be self-conscious, to be jealous, etc.

Questions

1. Study all the reactions cited in **I**, also the additional ones you may have added. Select ten of these reactions and indicate,

with reasons, whether the connection between stimulus and action is native or learned.[4]

2. Study all of the traits and actions listed in II. Select fifteen of these traits and indicate, with reasons, whether they are native or learned.

3. Comment upon the following statement: "Instinctive processes are normally blended into habituated conscious and voluntary processes. The pure instinct being essentially a theoretical matter, our main interests lie in the instinctive blends or fusions in which instinct may be more or less a dominant factor." (Seashore.)

4. Comment upon the following statement: The present conception of instincts is to regard them as specific responses with inherited neural mechanisms which will be set into action by specific stimuli or situations. Hence we ought to think of instinctive processes as opposed to instincts. The noun in the plural implies the existence of acts in tact, whereas the adjective recognizes the presence of instinctive traits in blends or complexes with other processes.

5. The most important educational value of a knowledge of instinctive tendencies lies in the fact that such tendencies can be utilized by the teacher to motivate and energize the learning process. Give three classroom illustrations of the energizing force of instinctive tendencies.

6. Arrange in the order of preference, with reasons, the following stimuli to study: corporal punishment, curiosity, desire to win the approval of parents and teachers, prizes, to display one's ability, interest, emulation, commendation.

7. Name five natural instincts of the child upon which education builds to-day. Of what use in the disciplining of pupils is the teacher's knowledge of the instincts of children? Illustrate.

8. Has the play element been sufficiently introduced into school activities? Illustrate how any elementary-school subject might be profitably taught as a game.

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[4] In determining whether or not the connection between stimulus and action is native or learned, keep in mind the action which is the result of the combination of a native and a learned reaction.

9. How may instinctive tendencies be modified and directed by the teacher?[5]

10. Why is it difficult to differentiate between instinct and reflex action? What are the differences usually given? Of what value is a knowledge of reflex action to the teacher? If of little value, why?

11. Differentiate between instinctive and habitual behavior, showing at the same time their interrelation.

12. What instinctive tendencies can be especially drawn upon in teaching of geography? In the teaching of thrift? In seeking to achieve a high score in arithmetic tests? In making good players on the ball team?

13. How would you teach a child to refrain from tormenting animals?

14. Should the teacher encourage rivalry between groups or individuals? Why?

15. State and describe three ways in which the school utilizes the child's natural tendency toward physical activity.

16. What school activities and extra-curricular activities may be utilized to counteract the natural desire on the part of some children to wander? Be definite.

17. How may the teacher utilize the natural tendency on the part of children to collect things as a motivating force in education? Give three illustrations.

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Colvin, S. S., *The Learning Process,* Chs. iii, iv.

James, William, *Talks to Teachers,* Ch. vi.

Norsworthy and Whitley, *Psychology of Childhood,* Chs. ii, iii, iv, xii.

McDougall, William, *Social Psychology,* Chs. ii, iii, iv.

[5] See Betts, *The Mind and Its Education,* Ch. xiii.

ROBINSON, J. H., *The Mind in the Making,* Ch. iii.
SEASHORE, C. E., *Introduction to Psychology,* Ch. xv.
STARCH, Daniel, *Educational Pyschology,* Ch. ii.
WOODWORTH, R. S., *Psychology,* Chs. v, vi.
——*Dynamic Psychology,* Chs. iii, viii.

EXPERIMENT 37

HEREDITY

Object.—*To study the evidences of physical and mental heredity.*

"When we speak of the inheritance of mental traits, we must remember first of all that heredity is primarily physical and only secondarily mental. This is to say that all hereditary transmission takes place by means of two parent cells of simple protoplasm, each cell being totally devoid of consciousness or mentality in the sense in which we understand it. Since, however, as we have already learned, our mental life is conditioned upon the limitations of the physical organism through which it works, we are justified in speaking of the inheritance of mental traits.

". . . Because of the close relation of the physical and mental, it may be worth while before taking up the discussion of mental heredity to notice briefly certain facts relative to physical heredity. . . ." [1]

Material.—Metal tape measure.

Procedure, I.—The following table gives the head circumferences of twenty pairs of children, each pair being from the same parents.[2] You are to determine whether or not there is a tendency for brothers and sisters to have the same-sized head. That is, you are to determine whether or not there exists a casual connection between the two groups of data, given in columns 2 and 4 of the table.

[1] Betts, *The Mind and Its Education,* Ch. xiv.
[2] The head circumference is not a diagnostic index of intelligence.

The application of the coefficient of correlation [3] will aid you in solving this problem. In determining the coefficient of correlation use the rank method formula.

HEAD CIRCUMFERENCES OF RELATED PAIRS OF CHILDREN *

Name	Circumference, inches	Name	Circumference, inches
1. C. Price	21.91	D. Price	21.87
2. J. White	21.89	F. White	21.40
3. A. Saxon	21.87	K. Saxon	21.80
4. E. Young	21.75	F. Young	21.59
5. H. Taub	21.67	L. Taub	21.54
6. D. Locke	21.50	C. Locke	20.70
7. K. Knox	21.40	R. Knox	20.87
8. D. Ryan	21.31	J. Ryan	22.30
9. L. Smith	21.20	N. Smith	22.00
10. F. Spier	21.14	A. Spier	21.00
11. J. Murray	21.01	F. Murray	20.95
12. M. Brown	20.97	E. Brown	21.74
13. F. Fuld	20.94	L. Fuld	21.15
14. G. Squier	20.86	K. Squier	20.99
15. R. Casey	20.82	N. Casey	20.92
16. C. Begg	20.78	F. Begg	20.65
17. F. Flynn	20.74	J. Flynn	20.60
18. N. Palmer	20.70	B. Palmer	20.75
19. J. Tall	20.68	E. Tall	21.63
20. R. Katz	20.61	C. Katz	20.80

* The table is fictitious but has been arranged so that the size of the correlation corresponds with the correlation found by K. Pearson and others in their studies of heredity.

Procedure, II.—You now need to obtain a random selection of individuals with whom to compare the findings set forth in the above table. Obtain this random selection by arranging the names of your classmates alphabetically. Then pair the first and second individual, the third and fourth, etc. These pairs will correspond to the brothers and sisters paired in the above table. If two members of the same family happen to be in the same class, do not include them in your study. After the names have been

[3] See pp. 209-213.

properly arranged, obtain the measurement of the head circumference of each member of the class.

Let each member of a pair obtain the head measurement of the other member. If these measurements are placed upon the blackboard as soon as they are obtained, the other members of the class can copy them with little difficulty.

In measuring the circumference of the head let the Experimenter stand at the right of the Subject, who should be seated. Let the Experimenter hold the tape with the thumb and forefinger of each hand at a length approximately that of the distance to be measured. Lift the tape over the Subject's head and apply it about the head at such a height as to pass around the largest part, that is, so that it will pass over the occipital and over the frontal prominences. Keep the tape horizontal and be sure that you work it well under the hair.

INTELLIGENCE QUOTIENTS OF RELATED PAIRS OF CHILDREN *

Name	I. Q.	Name	I. Q.
1. C. A.	130	D. A.	134
2. F. B.	118	P. B.	90
3. L. C.	110	M. C.	129
4. A. D.	107	E. D.	98
5. F. E.	105	G. E.	97
6. F. F.	105	N. F.	93
7. J. G.	103	R. G.	100
8. C. H.	101	G. H.	97
9. P. I.	100	F. I.	103
10. A. J.	100	H. J.	91
11. B. K.	100	S. K.	89
12. M. L.	96	H. L.	101
13. E. M.	95	M. M.	87
14. F. N.	93	G. N.	94
15. E. O.	91	S. O.	105
16. E. P.	90	B. P.	72
17. N. Q.	88	S. Q.	80
18. G. R.	80	F. R.	85
19. L. S.	74	B. S.	83
20. E. T.	68	B. T.	86

* The table is fictitious.

Obtain the coefficient of correlation from the data secured from these measurements.

Procedure, III.—The table printed on the preceding page gives the Intelligence Quotients[4] of twenty related pairs of children. Treat these data in a manner similar to that set forth in **I.**

Procedure, IV.—The following table gives the intelligence quotients of twenty pairs of individuals who are not related. Treat these data in the manner similar to that set forth in **II.**

To verify your correlations compare them with your classmates.

INTELLIGENCE QUOTIENTS OF UNRELATED PAIRS OF CHILDREN *

Name	I. Q.	Name	I. Q.
1. R. C.	119	C. O.	85
2. J. F.	85	C. P.	117
3. N. L.	88	D. P.	100
4. C. N.	96	L. S.	101
5 K. A.	95	F. F.	83
6. R. I	85	F. W.	60
7. R. P.	101	K. R.	109
8. P. C.	113	K. E.	101
9. S. W.	107	C. K.	108
10. A. O.	100	J. F.	113
11. E. E.	114	F. L.	94
12. M. T.	104	R. J.	93
13. K. K.	109	B. C.	119
14. J. Q.	95	T. H.	106
15. C. I.	113	D. R.	102
16. N. R.	115	P. A.	81
17. C. E.	59	O. C.	105
18. T. O.	85	L. F.	75
19. T. C.	68	E. T.	96
20. M. O.	107	P. Y.	81

* Table obtained by pairing individuals selected at random.

[4] An index of intelligence which makes possible a comparison of individuals of different chronological ages.

QUESTIONS

1. What is the coefficient of correlation between the head circumference of related pairs of children? What does this correlation signify?

2. What is the coefficient of correlation between the head circumferences of individuals who are not related? Is this a significant correlation? What does the comparison of this correlation with the one obtained for related pairs of children indicate?

3. What is the coefficient of correlation between the intelligence quotients of related pairs of children? What does this correlation signify?

4. What is the coefficient of correlation between the intelligence quotient of individuals who are not related? Is this a significant correlation? What does the comparison of this correlation with the one obtained for related pairs of children indicate?

5. Note the eye-color and hair-color of twenty individuals. Pair the first and second individuals, the third and fourth, etc. What percentage of pairs have approximately the same eye-color? The same hair-color? Note the eye-color and hair-color of ten pairs of siblings (children of the same parents), and obtain the percentage of pairs which have approximately the same eye-color. The same hair-color. What conclusions as to heredity can you draw from your observations?

6. Comment upon the following two statements: "Heredity and environment are each helpless and incomplete without the contribution of the other." (Betts.) "Nature predominates enormously over nurture only in the relative and not in the absolute sense." (Starch.)

7. In the light of your study of heredity comment upon the statement: Hardly "one person in a thousand makes all the absolute gain possible for him even in a single capacity." (Starch.)

8. What meaning and significance does the statement in Question 7 hold for the teacher?

9. The teacher should not interfere with the natural left-handedness of the child. Why not?

REFERENCES

BETTS, G. H., *The Mind and Its Education,* Ch. xiv.
AVERILL, E. A., *Psychology for Normal Schools,* Lessons 22-28.
CASTLE, W. E., *Heredity.*
CONKLIN, E. G., *Heredity and Environment in the Making of Men.*
LA RUE, D. W., *Psychology for Teachers,* Ch. xv.
NORSWORTHY and WHITLEY, *Psychology of Childhood,* Ch. i.
STARCH, Daniel, *Educational Psychology,* Ch. vi.
THOMPSON, J. A., *Heredity.*

EXPERIMENT 38

VARIATION OF SCHOOL MARKS

Object.—*To determine the variation of marks assigned to the same composition and to the same arithmetic paper by different individuals.*

Procedure, I.—Rate the following composition, written by a fifth-grade pupil. Mark the composition on a basis of 0 to 100 per cent; consider 75 per cent as lowest passing mark. The question presented to the child read: Write a composition of about 250 words on the topic, "An Exciting Experience."

AN EXCITING EXPERIENCE

One day it was very hot and we didn't know what to do.

This was our Gym. period, so we went over on the lawn and sat under a tree for a while in the shade.

After a while one of the girls said, "Let's play something." We all suggested that we would play ghosts. We started and played for a long while and then we got tired and we suggested that we would play something else so we played leap frog.

We were awfully hot now so we sat down in the shade and rested ourselves.

After a while one of the girls suggested that we would play statue. We had been playing awhile and it was my turn to be

swung around. The girl that was swinging had swung all the other girls and they were pretty heavy, then she took me and swung me around fast not thinking of how light I was she let me go and I fell on my left wrist. I heard it crack and I thought it was broke, they took me down in the Gym. and the Gym. teacher bandaged it up. It was not broke but it was sprained.

I bet there were fifty girls that asked me where I fell what I was doing and how it was done. Well, that was the last game that I played since then.

Procedure, II.—Rate the following paper in arithmetic, written by a fifth-grade pupil. Mark the paper on the basis of 0 to 100 per cent; consider 70 per cent as the lowest passing mark. The examples and problems presented to the pupil precede his solution, which is in italics.

ARIRTHMETIC EXAMINATION [1]

1. Add:

	20
74½	*10*
89⅗	*12*
6¾	*15*
169	$\frac{37}{20} = 170\frac{7}{20}$ *Ans.*

2. Subtract:

929⅐
— 270⅗

658$\frac{19}{35}$ *Ans.*

3. Multiply:

136
× 27¾

~~¾~~ *of* ~~136~~ = *102*

102
952
272

2774 *Ans.*

[1] The correct answers are: (1) 170 17/20; (2) 658 19/35; (3) 3774; (4) $7.00; (5) 1/3.

4. Mary earned $10.50 and gave ⅔ of it to her mother. How much did she give to her mother?

$$\tfrac{2}{3} \text{ of } \overset{3.50}{\cancel{10.50}} = 7.00 \quad \textit{Ans.}$$

5. A boy had 45 marbles. He lost 15. What part of the whole number did he lose?

$$\cancel{\tfrac{15}{45}} = \cancel{\tfrac{3}{9}} = \tfrac{1}{3} \quad \textit{Ans.}$$

After the entire class has rated the two papers, let each student, as his name is called, give first the mark assigned to the composition and then the mark assigned to the arithmetic paper. It will then be possible for each member of the class to obtain all of the marks assigned to the two papers.

Questions[1]

1. What is the range of marks for the composition? For the arithmetic paper? Median? Quartile deviation?

2. Construct two graphs which will represent the variation of the marks of the composition and of the arithmetic paper. Construct the graphs by letting the x-axes represent the percentages and the y-axes the frequencies. In recording the frequencies make dots directly over the percentage assigned, for example, if four individuals were assigned 80 per cent, four dots (vertically placed over each other) would be placed just over 80; do not join the dots by lines. Indicate the medians on the graphs.

3. Were certain marks used more frequently than others? Was there a tendency for the greater portion of the marks to be passing ones? What explanation can you give for the answer to these two questions?

4. How would you explain the variation of school marks?

5. Obtain a set of pupils' arithmetic papers. Let the class in conference determine the percentages to be assigned, points to be marked, etc. Assign papers to the members of the class so that

[1] See pp. 196-203, 207-209 for the statistics necessary to answer these questions.

each paper is marked five times. Have marks recorded on separate paper. Finally compare the marks and where differences exist let the class in conference decide the mark. This practice will, with the usual variability of marks in mind, serve as very good training.

References

Betts, G. H., *The Mind and Its Education,* pp. 259-261.

Monroe, W. S., *Measuring the Results of Teaching,* Ch. i.

Monroe, DeVoss, and Kelly, *Educational Tests and Measurements,* Ch. i.

Starch, Daniel, *Educational Psychology,* Ch. xxii.

——, *Educational Measurements,* Ch. ii.

EXPERIMENT 39

Individual Differences

Object.—*To investigate the general nature of individual differences.*

The performance of the previous experiment has convinced us that whatever differences we believe exist among individuals in the various school subjects cannot be judged scientifically by the historic and customary examinations. The marks assigned to such examinations give us data more valuable for judging the individual differences of the markers than the pupils who wrote the papers.

The experiments that follow will attempt to acquaint the student with the general nature of individual differences and also with standard intelligence and achievement tests which can be used for determining individual differences, etc. The achievement tests will indicate a way of reducing the variation of school marks.

Material.—One watch with second hand; for each student—transparent white paper, size of one page in the textbook; soft lead pencil; several ordinary paper clips.

Procedure, I.—Restudy Experiment 13 and Experiment 37 in order to obtain the measures of auditory acuity and

PERCEPTION OF NUMBERS[1]

5 1 6 8 4 9 2 3 7 0 1 2 7 5 0 4 8 6 9 3 4 1 8 9 0 2 5 6 3 7

7 8 0 5 1 3 4 2 6 9 2 4 0 9 7 6 1 5 3 8 3 2 0 4 1 5 7 9 6 8

3 5 9 7 8 4 6 1 0 2 5 1 8 2 3 7 4 9 6 0 8 5 9 3 2 4 1 0 7 6

2 7 3 9 6 5 0 8 1 4 9 7 3 6 1 5 0 2 8 4 0 4 7 8 5 9 6 2 1 3

4 2 5 3 0 1 7 9 8 6 3 8 6 0 9 1 5 4 7 2 9 3 6 7 4 8 0 1 2 5

9 4 7 0 3 8 5 6 2 1 6 0 9 3 8 2 7 1 4 5 7 8 1 0 9 6 4 3 5 2

0 9 8 2 5 6 1 7 4 3 8 3 5 4 6 9 2 0 1 7 6 0 2 1 3 7 9 5 8 4

1 0 4 6 2 7 9 5 3 8 0 6 2 8 4 3 9 7 5 1 2 7 4 5 6 0 3 8 9 1

8 6 1 4 9 2 3 0 5 7 4 5 1 7 2 8 6 3 0 9 1 9 5 6 8 3 2 7 4 0

6 3 2 1 7 0 8 4 9 5 7 9 4 1 5 0 3 8 2 6 5 6 3 2 7 1 8 4 0 9

[1] This test does not correlate positively with measures of general intelligence.

the head circumferences of the members of your own class. Take the measures of auditory acuity that served as a basis for determining your standards. Construct a column graph with these data. If necessary use class intervals of several points.[2] Take the measures of the head circumferences of the members of your class and construct a column graph for these data.

Procedure, II.—This experiment is to be performed by the class as a whole. The Instructor will keep a record of the time. Take the transparent piece of paper and place it directly over the page containing the series of numbers. Clip this paper to the page so it will not move. Do this before you read further.

The Instructor will select two one-digit numbers, for example, 3 and 8, and then say to the class, "Look at me. When I say, 'Go,' you are to cross out all of the 3's with a short horizontal stroke and place a small circle around all the 8's. You will have one minute in which to work. Work rapidly but accurately. Ready!—Go!" At the end of exactly one minute the Instructor will say, "Stop!"

Trace in the four numbers which fall at the angles of the rectangle, formed by the series of numbers; this will enable you to replace the transparent sheet of paper should you find it necessary to do so.

Count the number of 3's and 8's marked correctly. Any sort of circle or line, whether it be horizontal or vertical, should be counted correct. Count the errors, that is, the 8's that are crossed out and the 3's that are circled, and any other number that is marked, also omissions.

Obtain the results of the other members of the class. Tabulate the data in a frequency distribution, using an

[2] See pp. 190-196.

interval of 0–1.99, 2–3.99, etc., for the number of figures correctly marked and an interval of 0–0.99, 1–1.99, 2–2.99, etc. for the errors. On the basis of these two frequency tables construct column graphs.

Questions

1. Study the four graphs constructed for the previous experiments. To what extent are these graphs similar in form? If, instead of twenty or thirty measures, you had several thousand what changes do you suppose would occur in the shape of the curve?

2. Study the theoretical normal curve of distribution (Betts, *The Mind and Its Education,* p. 273). To what grade of ability or measure do the majority of individuals approximately belong—inferior, medium, or superior?

3. Comment upon the following statements: Abilities range without a break from the lowest to the highest. The dividing of groups of individuals into various classes, such as short, medium, tall, etc., on the assumption that they may be divided into distinct classes with gaps between them, is psychologically incorrect. However, such terms are of value because of their general descriptive meaning.

4. How much (approximately) greater are the largest measures than the smallest measures in your own study of individual differences?

5. If sets of achievement tests (already scored) are at hand, the class can plot the distribution of the scores and note the variation of abilities in school subjects. (Experiments which follow will consider achievement tests.)

References

Betts, G. H., *The Mind and Its Education,* pp. 270-274.

Cameron, E. H., *Psychology and the School,* Ch. xiv.

Hollingworth, L. S., *The Psychology of Subnormal Children,* Ch. i.

Starch, Daniel, *Educational Psychology,* Ch. iii.

Thorndike, E. L., *Educational Psychology, Briefer Course,* see Index.

EXPERIMENT 40

General Intelligence Tests

Object.—*To study a general intelligence test.*

Material.—Select one of the following group tests suitable for older students and adults:[1]

Army Alpha Group Examination[2]
Thurstone's Psychological Examination[3]
Mentimeter No. 2[3]
Otis Group Intelligence Scale, Advanced Examination[4]

Procedure, I.—After selecting one of these tests (or any other group intelligence scale), the Instructor will administer the test to the class, thereby familiarizing the students with the nature of general intelligence tests. The directions for giving the test are usually included in the manual of directions which accompany the test blanks. The directions for administering, and scoring, the Army Alpha Examination are given in Yoakum and Yerkes, *Army Mental Tests.*[5]

In order to obtain the coöperation of all the members of the class the tests can be numbered for identification, thereby making unnecessary the placing of names upon the test sheets.

Questions

1. What behavior did the Examiner expect of you while the test was being distributed and administered? In your answer

[1] If material necessary for this experiment is not available Experiment 41 may be substituted.
[2] C. H. Stoelting & Co., Chicago, Ill.
[3] Doubleday, Page & Co., Garden City, L. I., N. Y.
[4] World Book Company, Yonkers, N. Y.
[5] Henry Holt & Co.

consider the following: pencil or pen used; directions to be followed explicitly; clear desks; etc.

2. Describe the procedure and manner of the Examiner. In your answer consider the following: the preliminary instructions; the giving of the test directions; keeping record of time; etc.

Procedure, II.—Have each student score his own examination according to the standard directions and place the score on the front sheet of the test. If an adequate number of stencils for scoring are not available, each student should at least become familiar with this material and its use.

QUESTIONS

1. Is the scoring of these tests objective? Describe the ways in which the personal equation of the scorer has been eliminated.

2. Why is it impossible for several scorers, who follow the scoring directions explicitly, to get other than the same total score? Does the marking of the usual school examination result in such unanimity of judgment? Why not?

Procedure, III.—Let each student compare his score with the standard norms. These norms may be given in units of mental ages, grade norms, or percentiles. Collect the examination papers and read the scores to the class so that each student can construct his own frequency table.

QUESTIONS

1. How is a grade norm obtained? Mental-age norm?

2. What is the mean or median score of the class? Lowest and highest scores? Express these scores in terms of mental age, grade standard, or percentile.

3. Construct a column graph of the distribution of the class. Do individual differences in general intelligence exist in your class? How great are these differences?

REFERENCES

BETTS, G. H., *The Mind and Its Education,* Ch. xv.

GREGORY, Chester A., *Fundamentals of Educational Measurement,* Chs. iii, iv.

HINES, H. C., *A Guide to Educational Measurements,* Chs. vii, viii, ix.
PINTNER, Rudolph, *Intelligence Testing.*
STARCH, Daniel, *Educational Psychology,* Ch. vii.
WILSON and HOKE, *How to Measure,* Ch. x.

EXPERIMENT 41[1]

AUDITORY MEMORY SPAN TEST

Object.—*To study an auditory memory span test.*

Analysis of a general intelligence test will show that it consists of material designed to measure many mental functions, for example, ability to name opposites, ability to comprehend and follow printed directions, ability to note analogies, etc. The experiment which follows will familiarize you with one test designed to measure a separate mental function. This test could be included in a battery of other tests and thus make up a general intelligence test.[2] Failure or success in one test is not necessarily significant; failure or success in many tests is significant.

Material.—Pencil and paper with lines numbered from 1 to 12 for each student.

Procedure, I.—The Instructor will administer the test to the class. If the students are familiar with the test figures, others will need to be substituted. The Instructor will say to the class: "This is a test to see how many figures you can remember and write down after you have heard them read to you. You are to listen carefully and are not to begin to write until the signal 'Go!' is given each time. There will be two sets of four, five, six and seven figures, then three sets of eight and nine figures.

[1] If material for Experiment 40 is not available, substitute this experiment.

[2] Providing the battery of tests so constructed correlated positively with an accepted measure or criterion of general intelligence.

If you are unable to recall the figures when the signal to write is given, be sure that you make a mark in the space set apart for this series; this will then enable you to score your results easily." The figures should be pronounced with perfectly uniform emphasis, slightly faster than one per second. Avoid rhythm.

DIGITS FOR AUDITORY MEMORY SPAN [3]

Five Digits

3 1 7 5 9
4 2 8 3 5

Six Digits

3 7 4 8 5 9
5 2 1 7 4 6

Seven Digits

2 1 8 3 4 3 9
9 7 2 8 4 7 5

Eight Digits

7 2 5 3 4 8 9 6
4 9 8 5 3 7 6 2
8 3 7 9 5 4 8 2

Nine Digits

7 4 1 6 2 5 9 3 8
3 8 2 6 4 7 5 9 1
9 4 1 5 2 6 8 3 7

The standards given below for this test are those suggested by Professor Terman.[4] The standards given by

[3] Terman, *Measurement of Intelligence.*
[4] Terman, *ibid.*

Professor Terman are, however, for the digits given orally by the Subject and not in writing. Undoubtedly the writing of the digits by the student slightly changes the nature of the test; therefore the standards are only suggestive. The score is obtained by taking the series in which the Subject succeeds in recalling and writing correctly one or more sets of digits. The digits in a set must be in their correct position to be considered correct.

TENTATIVE STANDARDS

Digits	*Year Levels*
5	7- 9
6	10-13
7	14-17
8	18 (superior adult)
9	Above 18

Professor Gates gives the following standards for college students.[5] Standards are expressed in percentages:

Digits	*Percentage of College Students*
4	0
5	7
6	14
7	18
8	35
9	18
10	6
11	1
12	1

Let each student place on the sheet his digit memory span, his year level, and also the percentage of college students with similar or higher memory spans. Collect the papers and read the scores (digits) to the class so that the students can construct a frequency table.

[5] A. I. Gates, "The Mnemonic Span for Visual and Auditory Digits," *Journal of Educational Psychology*, October, 1916.

Questions

1. What behavior did the Examiner expect of you while the test was being given? In your answer consider the following: clear desks, directions to be followed explicitly, etc.

2. Describe the procedure and manner of the Examiner. In your answer consider the following: the preliminary instructions; the giving of the test directions; etc.

3. Is the test objective? That is, if the scoring directions are followed, will a group of scorers rating the same paper obtain the same identical score?

4. What is the mean or median score of the class? Lowest and highest scores? Express these scores in terms of mental age.

5. Construct a column graph of the distribution of the class. Do individual differences in auditory memory span exist in your class? How great are these differences?

References

Gates, A. I., "The Mnemonic Span for Visual and Auditory Digits," *Journal of Educational Psychology*, October, 1916.

Terman, Lewis M., *Measurement of Intelligence*, see Index.

Whipple, Guy, *Manual of Mental and Physical Tests*, Part II, pp. 150-204.

EXPERIMENT 42

Group General Intelligence Tests for Elementary-School Pupils

Object.—*To demonstrate the administration of a general intelligence test to elementary-school pupils, the scoring of that test, the use of standard norms, the obtaining of intelligence quotients.*

Material.—A recognized general intelligence test applicable to the elementary-school child. Some such tests are:

Illinois General Intelligence Scale, Examination I for Grades 3, 4, 5, and Examination II, Grades 6, 7, 8[1]

[1] Public School Publishing Co., Bloomington, Ill.

Haggerty Intelligence Examination, Delta I for Grades 1, 2, 3, and Delta II, Grades 3-9[2]
National Intelligence Tests, Form A or B, Grades 3-8[2]

Procedure, I.—The students, if possible, should witness the administration of a group test to children. Since most schools give these tests, this could be made part of the observation work of the student teachers. The students should also assist in the scoring. Each examination should be scored directly under the supervision of one familiar with testing and scoring, and should also be scored by at least two different students for purposes of checking.

QUESTIONS

1. Briefly describe the conditions, general directions, etc., necessary for administering a standard general intelligence test (see Experiment 40, **I**, Questions 1 and 2).
2. Describe the conditions and method of scoring a general intelligence test (see Experiment 40, **II**, Questions 1 and 2).

Procedure, II.[3]—The results of a test may be interpreted in terms of grade standards, mental-age norms, or percentiles. The norms given below are for the Haggerty Intelligence Examination, Delta II.[4]

STANDARD SCORES IN GENERAL INTELLIGENCE EXAMINATION, DELTA II, FOR EACH OF GRADES 3 TO 9, INCLUSIVE

Grade	3	4	5	6	7	8	9
Score	40	60	78	96	110	120	130

[2] World Book Co., Yonkers, N. Y.

[3] The data presented in **II** and **III** are to be used only if it is impossible for the students to assist in the scoring, etc. of tests as suggested in **I**.

[4] *Manual of Directions*, World Book Co., Yonkers, N. Y.

AGE NORMS FOR GENERAL INTELLIGENCE TEST, DELTA II

Age	8	9	10	11	12	13	14	15
Score	25	43	55	66	77	87	100	115

Take the scores of the following 22 pupils and indicate the grade norm and mental-age norm for each pupil. For example, if a pupil has a score of 79, the grade norm is 5, and the mental-age norm is 12 years 2 months. The scores of the pupils are:

A	60	L	99
B	65	M	99
C	78	N	104
D	80	O	109
E	85	P	111
F	89	Q	111
G	92	R	112
H	92	S	114
I	95	T	115
J	96	U	118
K	98	V	120

Procedure, III.—Two pupils may each have a mental age of 10 years 6 months, but one may be chronologically 9 years and the other 11 years. Needless to say, the 9-year-old child is the brighter of the two. We need, therefore, to take into consideration not only mental age but also chronological age when we judge the mental ability of a pupil. The relationship which the chronological holds to the mental age is expressed in the form of a fraction, the numerator of which is the mental age and the denominator of which is the chronological age. The resulting percentage is multiplied by 100 (to remove the decimal point), and the product is called the *intelligence quotient.* Let us illustrate:

$$\frac{\text{M.A.} = 10 \text{ years } 6 \text{ months}}{\text{C.A.} = 9 \text{ years } 0 \text{ months}} = \frac{126 \text{ months}}{108 \text{ months}} = 1.17$$

$$1.17 \times 100 = 117 \quad \text{I.Q.} = 117$$

$$\frac{\text{M.A.} = 10 \text{ years } 6 \text{ months}}{\text{C.A.} = 11 \text{ years } 0 \text{ months}} = \frac{126 \text{ months}}{132 \text{ months}} = 0.95$$

$$0.95 \times 100 = 95 \quad \text{I.Q.} = 95$$

Calculate the I.Q.'s [5] for the pupils whose mental ages you have determined on the basis of the Haggerty scores given in II. The chronological ages of these pupils are:

A	11 yrs. 4 mos.	L	13 yrs. 6 mos.
B	11 yrs. 11 mos.	M	10 yrs. 1 mo.
C	11 yrs. 6 mos.	N	13 yrs. 8 mos.
D	12 yrs. 2 mos.	O	12 yrs. 1 mo.
E	13 yrs. 0 mos.	P	12 yrs. 11 mos.
F	12 yrs. 8 mos.	Q	13 yrs. 3 mos.
G	14 yrs. 1 mo.	R	14 yrs. 2 mos.
H	12 yrs. 7 mos.	S	12 yrs. 3 mos.
I	13 yrs. 6 mos.	T	14 yrs. 1 mo.
J	14 yrs. 0 mos.	U	13 yrs. 4 mos.
K	14 yrs. 0 mos.	V	13 yrs. 9 mos.

It is valuable not only to have the mental ages and intelligence quotients of pupils, but also to know the percentage of children who equal or surpass the pupil in whom our immediate interests may lie. For example, if we know that a 9-year-old pupil has a mental age of 12 years and an I.Q. of 133, we do not yet know how many children selected at random are better or poorer than he. If the mental age was obtained on the basis of a Stanford-Binet test [6] we could say that such a pupil is in the upper 1 per cent.

Since I.Q.'s obtained on the basis of different tests are

[5] Tables prepared by Inglis (World Book Co.), West, and also Coxe (Public School Publishing Co.) can be used for readily obtaining quotients for intelligence or achievement tests.

[6] For the distribution of I.Q.'s on the Stanford-Binet Scale see Terman, *The Measurement of Intelligence*, p. 78, or Betts, *The Mind and Its Education*, p. 271.

not distributed in exactly the same way, we cannot, for example, take an I.Q. obtained on the basis of a Haggerty or Illinois scale and interpret that I.Q. in the light of the distributions given by Professor Terman for his Stanford-Binet scale. Professor Terman has found that about 1 per cent of unselected children have I.Q.'s on his scale of 70 or below 70. But an I.Q. of 60 to 74 on the Illinois Intelligence Examination[7] would place one in the lowest 7 per cent, and an I.Q. below 60 would place one in the lowest 1 per cent; that is, 6 per cent of unselected pupils on the Illinois Test have intelligence quotients between 60 and 74, and 1 per cent below 60.

Ignorance of these facts has caused many misinterpretations of the intelligence quotient. The writers, therefore, suggest that the term intelligence quotient be used only for intelligence quotients obtained on the basis of the Stanford-Binet Scale, and that, whenever the intelligence quotient is obtained on the basis of another intelligence test, the term be prefixed by the name of the test, for example, Haggerty I.Q. 110, Illinois I.Q. 90, etc. In lieu of this discussion, use only the standards for a test published by the authors of that test. Since Haggerty does not give such a distribution of I.Q.'s, we cannot state how many children selected at random equal or surpass a pupil in whom our interests may lie.

Questions

1. Criticize the following statement made by a sixth-grade teacher: "I cannot understand why John does not do as well in his lessons as James; they both have I.Q.'s of 100." (John was 10 years old chronologically and James was 12.)

2. (*a*) Criticize the following administrative plan of a sixth-grade teacher: On the basis of an intelligence test the I.Q.'s of

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[7] Monroe-Buckingham, Illinois Examination I and II, *Teachers' Handbook*, p. 25.

the 35 pupils were obtained, the class was then divided into slow, average, and fast sections according to these I.Q.'s. (*b*) What procedure would you follow if you desired to form three similar sections?

3. If pupils were placed in sections in the first grade of school on the basis of mental ages, would they still be in the same sections at the end of the elementary-school course provided they did work at all times commensurate with their intelligence? Give reasons for your answer.

4. What factors other than general intelligence make for success in academic-school subjects? In grading school pupils why is it necessary to take into consideration their achievement in the school subjects as well as native ability, energy, perseverance, health, etc.?

5. Theoretically (on the basis of the probability curve), there ought to be as many pupils of superior intelligence as of low intelligence in our schools, and probably, approximately, there are. Yet school statistics show about ten "repeaters" for every one "skipper" in the elementary grades. How do you account for this disparity? What do you think is the ultimate effect of such a situation on national outcome and achievement?

References

Betts, G. H., *The Mind and Its Education,* Ch. xv.

Haggerty, N. E., *Manual of Directions,* Intelligence Examination, Delta I and II.

Hines, H. C., *A Guide to Educational Measurements,* Chs. vii, x, xi, xii, xiii.

Monroe and Buckingham, *Teachers' Handbook,* Illinois Examination I and II.

Pintner, Rudolph, *Intelligence Testing.*

Pressey and Pressey, *Introduction to the Use of Standard Tests,* Ch. v.

Terman, Lewis M., *The Measurement of Intelligence.*

Wilson and Hoke, *How to Measure,* Ch. x.

EXPERIMENT 43[1]

Standard Reading Achievement Tests

Object.—*To study the use and interpretation of a standard achievement test in reading.*

The ability that a child displays in school work is due in part to the native intelligence of the child and in part to the teaching which he has received at school or home. The general intelligence test attempts to measure the native intelligence. Progress and attainment in school work are measured by standardized achievement tests.

Since the standard achievement tests are administered and scored in a manner similar to the general intelligence tests, this experiment will be concerned with the use and interpretation of reading tests.

Material.—One or more of the silent reading tests. The list which follows contains some of the tests in general use:

Haggerty-Noonan Achievement Examination in Reading, Sigma I, for Grades 1-3[2]

Thorndike-McCall Reading Scale (ten forms available, for Grades 2-12)[3]

Monroe Silent Reading Revised, Test 1, Grades 3, 4, 5; Test 2, Grades 6, 7, 8 (three forms of each test available)[3]

Stone-Murphy Narrative Reading Scale, for Grades 3 and 4, for Grades 5 and 6, and for junior high school[3]

Courtis' Reading Test[4]

Kansas Silent Reading Tests[5]

Holley Sentence Vocabulary Scale[3]

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[1] Restudy Experiment 40 with special attention to the administration and scoring of general intelligence tests.

[2] World Book Co., Yonkers, N. Y.

[3] Public School Publishing Co., Bloomington, Ill.

[4] S. A. Courtis, 82 Elliott St., Detroit, Mich.

[5] Kansas State Normal School, Emporia, Kan.

Thorndike's Visual Vocabulary Scale[6]
Gray's Oral Reading Test.[7]

Procedure.—If possible, have the students observe some teacher giving the test, and also have them assist in the scoring of these tests. If the students cannot observe the administration of the tests, they should be given copies of tests which have been used.

QUESTIONS

1. What should the standard score be on the test used for the class you have observed? For the classes just below and just above the one observed?

2. What is the average score of the class you observed? What percentage of the class have scores equal or greater than the standard score?

3. Graphically represent the distribution of the scores of the class. What light does this distribution throw upon individual differences in reading? Grade norm for lowest score? For highest score?

4. What is the *reading age*[8] of the best, poorest, and median pupils in the grade? If the *reading quotient* is obtained by dividing the *reading age* by the chronological age, what are the reading quotients for these three pupils?

5. What is silent reading? What is oral reading? Relative importance of each? Do we place too much emphasis on oral reading in our teaching?

6. What is meant by comprehension of reading? Rate of reading? Answer these questions in the light of standard reading tests.

7. Does the fast or slow reader comprehend more material in the same period of reading? To answer this question divide the class in half according to their rate of reading, or select the 10 fastest readers and the 10 slowest readers, and then obtain the

[6] Teachers College, Columbia University, New York, N. Y.
[7] Public School Publishing Co., Bloomington, Ill.
[8] Some of the achievement tests do not have age norms. See Experiment 47.

mean comprehension score of these two groups. (This can only be done if the test used measures both speed and comprehension.)

8. In what way does a standard achievement test in reading differ from the usual classroom reading test?

9. Of what value is a vocabulary test?

10. What is the best way to increase vocabularies of pupils: by teaching words from the speller, dictionary, or from the material being read? Give reasons.

11. Are all errors in reading comprehension due to a lack of reading vocabulary, or are some due to inability to relate words, phrases, and clauses, and some due to a tendency to guess or react to part of the questions, and some to inferior general intelligence?

12. Since pupils cannot be expected to learn all of the new words that they meet in their reading, a selection of vocabulary words must be made. On what basis would you make the selection?*

13. If the average score of a sixth-grade pupil in the rate of silent reading is equal to the standard for the eighth grade, while his comprehension score is equal to the standard for the fifth grade, what remedies, if any, would you suggest? Why?

14. Briefly describe one silent reading test as to purpose, organization, etc.

References

HINES, H. C., *A Guide to Educational Measurements,* Chs. xiv, xviii.

MONROE, W. S., *Measuring the Results of Teaching,* Chs. ii, iii.

MONROE, DEVOSS, and KELLEY, *Educational Tests and Measurements.*

PRESSEY and PRESSEY, *Introduction to the Use of Standard Tests,* Ch. viii.

STARCH, Daniel, *Educational Psychology,* Ch. xvi.

THORNDIKE, E. L., *The Teachers' Word Book* (Teachers College, Columbia University).

WILSON and HOKE, *How to Measure,* Ch. v.

* See Thorndike, *The Teachers' Word Book,* Teachers College, Columbia University, New York City.

EXPERIMENT 44

Standard Arithmetic Achievement Tests

Object.—*To study the use and interpretation of standard achievement tests in arithmetic.*

Material.—At least one test from each of the two groups given below, or tests similar to those included in these two groups.

Group A.—Arithmetic Fundamentals

Woody-McCall Mixed Fundamentals, Form 1 or 2[1]
Monroe Diagnostic Arithmetic, Part 1, Integers, Grades 4-8; Part 2, Integers, Grades 5-8; Part 3, Common Fractions, Grades 6-8; Part 4, Decimal Fractions, Grades 6-8[1]
Cleveland Survey Arithmetic Test, Grades 3-8[1]
Monroe General Survey Arithmetic, Scale 1, Grades 3-4-5; Scale 2, Grades 6-7-8[1]
Courtis Standard Research Tests, Series B[2]
Woody's Arithmetic Tests[3]

Group B.—Arithmetic Problems

Buckingham Scale for Problems in Arithmetic, Division 1, Grades 3-4; Division 2, Grades 5-6; Division 3, Grades 7-8[1]
Monroe Standardized Reasoning Tests in Arithmetic, Test 1, Grades 4-5; Test 2, Grades 6-7; Test 3, Grade 8[1]
Stone's Reasoning Tests[3]
Starch's Arithmetical Scale A[4]

Procedure.—If possible, have the students observe some teacher administering the tests and also have them assist in the scoring of these tests. If the students cannot ob-

[1] Public School Publishing Co., Bloomington, Ill.
[2] S. A. Courtis, 82 Elliott St., Detroit, Mich.
[3] Teachers College, Columbia University, New York City.
[4] Daniel Starch, Madison, Wis.

serve the administration of the tests, they should be given copies of tests that have been used.

Questions

1. Compare one test listed in Group A with a test listed in Group B as to purpose and organization.

2. What should the standard scores be in the test used for the class you observed?

3. What are the average scores of this class? What percentage of the class have scores less than the standard scores?

4. Graphically represent the distributions of the scores of the pupils in the test. Describe the individual differences that exist. Grade norm for lowest score? For highest score?

5. What are the *arithmetic ages*[5] (in fundamentals and also in problems) of the best, poorest, and median pupils in the grade. If the *arithmetic quotient* is obtained by dividing the *arithmetic age* by the chronological age, what are the arithmetic quotients of these three pupils?

6. Is the slow pupil on the average more accurate, or is the fast pupil more accurate? (Devise the method for answering this question.)

7. Does the ability to perform well in an arithmetic test in fundamentals insure an ability to use these same fundamentals when they occur in problems? (Construct ten examples in fundamentals, then construct ten problems necessitating the use of these same ten examples. First give one half of the class the ten examples while the other half take the problems; then give the first half the problems while the second half take the examples. Compare the scores of individual children in these two tests; also compare the class averages in these two tests. If time permits, the coefficient of correlation might also be used to answer the question.)

8. What part does the knowledge of words and comprehension of reading play in solving problems in arithmetic?[6]

9. What is the purpose of a general test such as the Woody-

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[5] Some of the achievement tests do not have age norms. See Experiment 47.

[6] See Monroe, *Measuring the Results of Teaching*, p. 165.

McCall? The purpose of a diagnostic test, such as the Monroe Diagnostic Arithmetic Tests?

10. Of what value are grade standards to teachers in establishing definite objectives for teaching? Does a knowledge of these objectives aid the pupils?

11. If a pupil is markedly above his grade standard in the fundamentals of arithmetic, would you still insist upon drill for him or would you assign him other work? Why?

12. How can you determine that your drill is effective? How can you determine whether you are giving undue emphasis and time to arithmetic work?

13. How may we teach pupils to think in arithmetic? (See Experiment 34.) How may we eliminate absurd answers commonly given by pupils?

14. Describe one standard arithmetic test devised to measure ability in fundamentals and one devised to measure ability in problems.

References

Hines, H. C., *A Guide to Educational Measurements,* Ch. xvii.

Monroe, W. S., *Measuring the Results of Teaching,* Chs. iv, v, vi.

Monroe, DeVoss and Kelly, *Educational Tests and Measurements,* Ch. ii.

Pressey and Pressey, *Introduction to the Use of Standard Tests,* Ch. v.

Starch, Daniel, *Educational Psychology,* Ch. xx.

Wilson and Hoke, *How to Measure,* Ch. vi.

EXPERIMENT 45

Achievement Tests in Handwriting, Spelling, Grammar, and Composition

Object.—*To study the use and interpretation of standard achievement tests in handwriting, spelling, grammar, and composition.*

Material, I.—One of the handwriting scales. The list which follows contains some of the scales in general use:

Ayres Handwriting Scale, "Gettysburg Edition" [1]
Thorndike's Handwriting Scale [2]
Freeman's Diagnostic Handwriting Scale [3]

II. One of the spelling scales. The list which follows contains some of the tests in general use:

Buckingham Extension of the Ayres Spelling Scale [1]
The Iowa Spelling Scales, E. J. Ashbaugh [1]
Monroe Timed Sentence Spelling Tests [1]

III. One or more of the following grammar tests, or similar ones:

Charters' Diagnostic Language Tests, Grades 3-8, Pronouns, Verbs, Miscellaneous [1]
Charters' Diagnostic Grammar Tests, Grades 7-8, Pronouns, Verbs, Miscellaneous [1]
Starch's Punctuation Scale [1]
Haggarty's Grammar Test.[4]

IV. One of the following composition scales, or a similar one:

Willing Scale for Measuring Written Composition [1]
Nassau County Supplement to the Hillegas Scale for Composition [2]
Harvard-Newton Composition Scale [5]

Procedure, I.—If possible, have the students observe some teacher giving the test and also have them assist in the scoring of samples of writing. If the students cannot observe the administration of the tests, they should be given samples of children's writing to grade on one of the scales.

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[1] Public School Publishing Co., Bloomington, Ill.
[2] Teachers College, Columbia University, New York City.
[3] Houghton, Mifflin Co., Boston, Mass.
[4] University of Minnesota, Minneapolis, Minn.
[5] Harvard University Press, Cambridge, Mass.

QUESTIONS

1. What are the essential elements to be measured in handwriting? How is speed of handwriting measured? How is quality of handwriting measured?

2. In the terms of the scale used, what is the standard speed and quality for a fifth-grade class? An eighth-grade class?

3. If a fifth-grade child has eighth-grade quality but only fourth-grade speed in handwriting, what remedies would you suggest? Why?

4. Of what value is the practice of having children compare their own writing with the scale?

5. "A teacher may judge the handwriting of his class by watching the pupils while they write, or by examining the specimens which they have written. Which is the better method, if the purpose is to make comparisons of classes? Which is better for discovering the handwriting defects of individual pupils? What factors would you keep in mind in watching children while they write? What factors in the other method?"[6]

6. Regrade five specimens of handwriting for three consecutive days. Have several members of your class regrade the same specimens in like manner. What is the consistency of rating?

7. Briefly describe the handwriting scale as to purpose, use and organization.

Procedure, II.—If possible, have the students observe some teacher giving one of the tests listed under **II** in "Materials" and also have them assist in the scoring of papers. If the students cannot observe the administration of the test, they should have copies of the scales and also children's work.

QUESTIONS

1. What words should pupils learn to spell?[7]

2. Indicate what should be expected in spelling ability on the test used for third-grade and seventh-grade classes.

[6] From Monroe, *Measuring the Results of Teaching*, p. 234.

[7] See Starch, *Educational Psychology*, p. 323, and Monroe, *Measuring the Results of Teaching*, Ch. vii.

3. Select ten spelling words from a scale. Construct with these same ten words a sentence spelling test. Divide the class in half, and give to one half the isolated spelling words and to the other the sentence spelling test. On the following day give the first half of the class the sentence spelling test and the other the isolated spelling words. Does the ability to spell words in isolation indicate ability to spell the same words in sentences?

4. Would you assign the same spelling words to pupils for home study, or would you dictate the words first and have each pupil make up his own spelling list? Why?

5. How may spelling scales be used to motivate the teaching of spelling?

6. Suggest a game that might be used in teaching spelling.

7. Briefly describe a spelling scale as to purpose, use, and organization.

Procedure, III.—Let the students inspect one or more of the tests listed under **III** in "Materials" noting their purpose, use, and organization.

QUESTIONS

1. Indicate the values of a grammar test for the pupil and for the teacher.

2. By what method may the teacher list the types of errors in grammar most frequently made by the pupils?

3. Briefly describe a grammar test, as to purpose, use, and organization.

Procedure, IV.—Grade the composition, "An Exciting Experience" (Experiment 38) on one of the scales listed under **IV** in "Materials."

QUESTIONS

1. Obtain the ratings of all of the members of the class. Does the use of the scale insure the same rating by all? Does the use of the scale reduce the variations in marks that were evident when the composition was rated without a scale?

2. In what way can a teacher construct a composition scale

on the basis of his pupils' work? Of what advantage is such a tentative scale?

3. In what way can the pupils use such a scale as the Willing Scale?

4. Briefly describe a composition scale as to purpose, use, and organization.

References

Hines, H. C., *A Guide to Educational Measurements,* Chs. xvi, xv, xix.

Monroe, W. S., *Measuring the Results of Teaching,* Chs. vii, viii, xix.

Monroe, DeVoss and Kelly, *Educational Tests and Measurements,* Chs. iv, v, vi.

Pressey and Pressey, *Introduction to the Use of Standard Tests,* Chs. vii, xix.

Starch, Daniel, *Educational Psychology,* Chs. xvii, xviii, xix.

Wilson and Hoke, *How to Measure,* Chs. ii, iii, vi.

EXPERIMENT 46

Standard Achievement Tests in History and Geography

Object.—*To study the use and interpretation of standard achievement tests in history and geography.*

Material.—One or more tests from each of the following groups, or similar tests:

History Group

Hahn History Scale[1]
Harlem Test for Information in American History[1]
Barr Diagnostic Tests in American History, Series B[1]
Gregory Tests in American History[2]

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[1] Public School Publishing Co., Bloomington, Ill.
[2] C. A. Gregory, University of Cincinnati, Cincinnati, Ohio.

GEOGRAPHY GROUP

Posey-Van Wagenen Geography Scale; Scale Information R, Div. 1, Grades 5-6; Div. 2, Grades 7-8; Scale Thought S, Div. 1, Grades 5-6; Div. 2, Grades 7-8[1]

Hahn-Lackey Geography Scale[1]

Buckingham-Stevenson Place Geography Tests for the World and the United States[1]

Procedure.—Let the students inspect the tests, noting their purpose, use, and organization.

QUESTIONS

1. School subjects, such as reading and arithmetic, are called *fundamental tool subjects,* while such subjects as history and geography are called *content subjects.* What is meant by this statement? What difficulties are involved in devising standard tests for measuring progress in content subjects?

2. Can achievement tests measure more than the mere informational side of a subject? Analyze a history scale, such as the Hahn Scale, and select three questions planned to measure the power to think. Select three similar questions from a geography test, such as the Posey-Van Wagenen Thought Test.

3. Do you believe that there is a correlation between the ability to think and the ability to remember facts in history? Why?[2]

4. How should the questions for a standard history or geography scale be selected: from one textbook, by examining many textbooks for facts common to all, or by the consensus of opinion of many teachers? Why?

5. Certain investigators[4] have been trying to determine the content for history books by discovering the frequency of reference to persons and events made in current newspapers and magazines. Could the results of such an investigation be taken as final? Why?

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[2] See B. R. Buckingham in *School and Society,* April 14, 1917, Vol. 5, p. 443.

[4] W. C. Bagley, "An Analysis of the Determination of Minimum Essentials in Elementary Geography and History," *Fourteenth Yearbook* of the National Society for the Study of Education, pp. 131-146.

6. Briefly decribe one standardized test in history as to purpose, use, and organization.

7. Briefly describe one standardized test in geography as to purpose, use and organization.

References

HINES, H. C., *A Guide to Educational Measurements,* Chs. xxi, xx.
MONROE, W. S., *Measuring the Results of Teaching,* Ch. x.
PRESSEY and PRESSEY, *Introduction to the Use of Standard Tests,* Ch. vi.
STARCH, Daniel, *Educational Psychology,* Ch. xxi.

EXPERIMENT 47

The Accomplishment Quotient

Object.—*To become familiar with the accomplishment quotient and the interpretation of intelligence and achievement tests.*

In our study of intelligence tests we learned how to obtain the I. Q., and also the meaning of this quotient. The reading and arithmetic quotients were referred to in our study of achievement tests. It is also possible to obtain educational quotients for the other school subjects. Just as we speak of the Haggerty I. Q. so we should indicate the test used to obtain the educational quotient, for example, Monroe Reading Comprehension Quotient, 98. We should only use the shorter term, reading quotient, when our readers or hearers know the source of our data.

The I. Q., according to Professor Terman and others, remains almost constant throughout the elementary-school life of pupils. Achievement tests attempt to measure material that the pupil gains from school training; therefore, the educational quotient is bound to change in magnitude as the school opportunity of the pupil varies.

As we have already learned, the I. Q.'s of children of the same chronological age vary considerably; therefore, when we consider the educational quotient, we should also take the I. Q. into con-

sideration. Dr. Franzen has suggested a method for doing this.[1] He suggests that the average educational age (the arithmetic mean of the educational ages obtained on the basis of the achievement test given) of a pupil be obtained and that this be divided by his mental age; the resulting quotient is designated as the *accomplishment quotient.* The accomplishment quotient roughly indicates whether or not a pupil is doing as well in his school work as his mental age indicates he should be doing. To illustrate:

$$\text{Accomplishment Quotient} = \frac{\text{Educational Age}}{\text{Mental Age}}, \text{ or } \frac{\text{E. Q.}}{\text{I. Q.}}$$

For example: if a pupil's chronological age, or C. A., is 13 years, his mental age, or M. A., is 12 years; his I. Q. is 92; and educational age, or E. A., is 10; his educational quotient, or E. Q., is 77. Then:

$$\text{Accomplishment Quotient} = \frac{\text{E. A. } 10}{\text{M. A. } 12}, \text{ or } \frac{\text{E. Q. } 77}{\text{I. Q. } 92} = 83+$$

To summarize: first, obtain on the basis of one or more intelligence tests the mental age of a pupil. If two or more general intelligence tests are used, take the arithmetical mean as the mental age. Second, administer several achievement tests in at least the subjects of reading and arithmetic, and if possible, in several more subjects. Third, obtain the educational ages for each subject, and then obtain the arithmetical mean of these ages, taking this as the mean educational age. Fourth, the accomplishment quotient is now secured by making the numerator of the fraction the mean educational age and the denominator the mean mental age. As previously stated, the educational and intelligence quotients may be substituted respectively for the educational and intelligence ages.

Batteries of intelligence and achievement tests can now be obtained so that it is not absolutely necessary for the teacher to make up his own battery of tests. Some of these tests in general use are: Illinois Examination 1,[2] Grades 3, 4, 5; Examination 2,

[1] R. Franzen, *The Accomplishment Ratio,* Teachers College Contributions to Education.

[2] Public School Publishing Co., Bloomington, Ill.

Grades 6, 7, 8; The Lippincott-Chapman Classroom Products Survey Tests;[3] The Stanford Achievement Test;[4] Otis Classification Test;[4] Pintner-Marshall, Mental-Educational Survey Tests.[5]

Space does not permit a discussion of the limitations of the A. Q.; for such a discussion the reader must be referred elsewhere.[6] The questions included in this experiment will call attention to some of the limitations of the A. Q. Some writers on the subject use terms that differ somewhat from those used in this discussion; however, the meanings of these terms are obvious.

Since the authors of many standard achievement tests give only grade norms, such tests cannot be used for obtaining the accomplishment quotient until the grade norms have been transmuted into ages. Professor McCall suggests a method for the transmutation of grade norms into age norms.[7] Ayres found the median age for entering school was 80 months. Terman found that 12.6 months (including vacation) on the average were necessary for the average pupil to complete each school grade, Ayres found 12.8 months necessary, and Kelly 13.2 months. McCall concludes that 13 months may be taken roughly as the average time necessary to complete one school grade. Taking 13 months as the average time necessary to complete each school grade, and 80 months as the average age for pupils entering school, McCall suggests a "temporary method" for the transmutation of grade norms into age norms. The table which follows is adapted from the table suggested by McCall.

This table is a tentative one. The average time to advance from the tenth to the eleventh grade is undoubtedly greater than the average time necessary to advance from the third to the fourth grade, yet 13 months is the average time taken as necessary

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[3] B. Lippincott Co., Philadelphia, Pa.

[4] World Book Co., Yonkers, N. Y.

[5] College Book Store, Columbus, Ohio.

[6] Toops and Simonds, "What Shall We Expect from the A. Q.?", *Journal of Educational Psychology*, December, 1922, and January, 1923; G. M. Ruch, "The A. Q. Technique," *Journal of Educational Psychology*, September, 1923.

[7] *How to Measure in Education*, pp. 32-36.

TENTATIVE AVERAGE AGE OF PUPILS IN SCHOOL GRADES

A Table for Converting Grade Norms into Educational Ages

Grade	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
I	81	82	83	84	85	86	87	88	89	90
II	94	95	96	97	98	99	100	101	102	103
III	107	108	109	110	111	112	113	114	115	116
IV	120	121	122	123	124	125	126	127	128	129
V	133	134	135	136	137	138	139	140	141	142
VI	146	147	148	149	150	151	152	153	154	155
VII	159	160	161	162	163	164	165	166	167	168
VIII	172	173	174	175	176	177	178	179	180	181
IX	185	186	187	188	189	190	191	192	193	194
X	198	199	200	201	202	203	204	205	206	207
XI	211	212	213	214	215	216	217	218	219	220
XII	224	225	226	227	228	229	230	231	232	233

to complete all school grades. In the absence of age norms, this table, in spite of its limitations, is perhaps the best method for transmuting grade norms into age norms.

How is the table to be used? Let us suppose that the grade norms for Reading Scale X are:

Grade III ..... Score 25
Grade IV ..... Score 38
Grade V ..... Score 45, etc.

We need to change these grade norms into educational ages. Let us suppose that the grade norms were obtained during the month of January; the tentative age for the third grade for the month of January is 111 months, for the fourth grade 124 months, and the fifth grade 137 months. Our age norms, therefore, are:

Grade	*Score*	*Educational Age*
III	25	111 mos.
IV	38	124 mos.
V	45	137 mos.

If a pupil has a score of 28, what is his educational age? The answer is $111 + \frac{3}{13}$ of 13, or 114 months. If a pupil has a score of 40, his educational age is $124 + \frac{2}{7}$ of 13, or 128 months.

Procedure.—Study the preceding discussion. Solve and answer the problems and questions which follow.

QUESTIONS

1. The June grade norms of a spelling scale are:

Grade III	10	Grade VI	46
Grade IV	23	Grade VII	55
Grade V	36	Grade VIII	62

What are the educational ages for the scores 10 to 62 inclusive?

2. Work out the various subject quotients and the accomplishment quotients for the two following pupils:

MARGARET G. ———.

Grade V. Born June 24, 1910. Age when examined, 12 years. 5 mos.

Haggerty Intelligence Examination, Delta II	M. A.	9-11	*I. Q.?*
Illinois Intelligence Examination I	M. A.	10-10	*I. Q.?*
Monroe Arithmetic	Age	9- 0	*E. Q.?*
Woody-McCall Mixed Fundamentals (Arith.)	Age	9- 6	*E. Q.?*
Language Completion Exercise	Age	12- 7	*E. Q.?*
Thorndike-McCall Reading Scale	Age	11- 3	*E. Q.?*
Monroe Silent Reading Scale			
Comprehension	Age	10-10	*E. Q.?*
Rate	Age	9- 0	*E. Q.?*
Spelling List, X and Y	Age	9-10	*E. Q.?*

Average Mental Age? Average I. Q.?
Average Educational Age? Average E. Q.?
Accomplishment Quotient?

BLANCHE B. ———.

Grade VI. Born Aug. 23, 1910. Age when examined, 13 yrs. 3 mos.

Haggerty Intelligence Examination, Delta II	M. A.	14- 8	*I. Q.?*
Illinois Intelligence Examination I	M. A.	14- 4	*I. Q.?*
Monroe Arithmetic	Age	12- 0	*E. Q.?*
Woody-McCall Mixed Fundamentals (Arith)	Age	12- 9	*E. Q.?*
Language Completion Exercise	Age	13- 6	*E. Q.?*
Thorndike-McCall Reading Scale	Age	14- 1	*E. Q.?*
Monroe Silent Reading Scale			
Comprehension	Age	13-11	*E. Q.?*
Rate	Age	12- 0	*E. Q.?*
Spelling List, X and Y	Age	15- 0	*E. Q.?*

Average Mental Age? Average I. Q.?
Average Educational Age? Average E. Q.?
Accomplishment Quotient?

3. Analyze the above two cases, and, where regrading, special instruction, etc., are needed, make the necessary suggestions, with reasons.

4. In what way may the accomplishment quotient be utilized for motivating school work?

5. Since the A. Q. tends to take into account the native abilities of pupils, would it be a somewhat fairer basis for marking children on report cards than the present method, which usually takes into account only the progress made in the subject without regard to the pupils' native capacities?

6. Comment upon the statement: The A. Q. is not, strictly speaking, a diagnostic measure for poor school work; it only points out the pupils who need treatment.

7. A pupil of a mental age of 12 who is in the fourth grade cannot be expected to have the same educational age as a pupil of the same mental age who is in the sixth grade. Why?

8. The A. Q. assumes a perfect correlation between general intelligence and school ability, but at the best this correlation is about 87 (in the case of handwriting the correlation is almost 0). The A. Q. (implying perfect correlation of E. Q. and I. Q.), when applied to specific school subjects, would seemingly perpetuate the academic standard on the most specific of subjects to which this procedure may be applied. In lieu of these statements should a teacher always expect an A. Q. of 100 in all subjects (handwriting, etc.) from all pupils? Why not?

9. Comment upon the statement: An I. Q. of 60 involving an efficiency of an A. Q. of 100 is, after all, acquiring educational assets that will be valued by the world as an E. Q. of 60.

References

FRANZEN, R., *The Accomplishment Quotient,* Teachers College Contributions to Education.

GREGORY, C. A., *Fundamentals of Educational Measurement,* Ch. vi.

HINES, H. C., *A Guide to Educational Measurements,* Chs. xxviii, xxix, xxx.

MCCALL, William, *How to Measure in Education,* see Index under

Accomplishment quotient, Educational age, Educational quotient.

RUCH, G. M., "The A. Q. Technique," *Journal of Educational Psychology*, September, 1923.

TOOPS and SIMONDS, "What Shall We Expect from the A. Q.?", *Journal of Educational Psychology*, December, 1922, and January, 1923.

WILSON and HOKE, *How to Measure*, Ch. viii.

EXPERIMENT 48

THE COMPARISON OF GROUPS

Object.—*To compare the ability of two groups in a general intelligence or achievement test.*

The teacher at times desires to learn how her class compares in a standard test with a similar grade in another school, or with the standard norm for that test. Such comparison is often inaccurately made by obtaining the mean ability of the two groups, and then concluding that the group with the higher mean is the better. An examination of the following means will convince one of the futility of this method.

Group I	Group II	Group III
6	8	0
7	8	2
8	8	11
9	8	12
10	8	15
$5 \overline{)40}$	$5 \overline{)40}$	$5 \overline{)40}$
8	8	8

The means of these three groups are equal, but from the viewpoint of the teacher they present three entirely different situations. The mean, since it is merely a central tendency, indicates the one measure which best represents the whole distribution, but it gives no indication of the variability of the group, of the extent to which the measures cluster about the central tendency.

The comparison of the quartile deviations, mean deviations, and the standard deviations,[1] indicate whether one group in a particular test is more or less variable than another. For example, if we know that the mean grade norm on an achievement test is 40, and that the quartile deviation is 10, we can compare our class with that group by obtaining the mean and quartile deviation of our group. If the mean of our group is 40, and the quartile deviation is 5, then we know that our group is more homogeneous in the trait concerned. But if the mean is less or greater than 40, comparison is difficult because we have no common central tendency to serve as a pivot for our comparison; hence we need still another method for comparing groups.

Let us illustrate this method, taking for granted that the group with which we are to compare our group has a mean score of 40. We now need to prepare a frequency distribution of our class and then determine the percentage in our group who have a score of 40 or greater than 40. If 50 per cent of our group have a score of 40 or greater than 40, the two groups may be considered as being *approximately* equal. If 60 (or more) per cent of our group have a score greater than the mean standard score, then our group may be considered superior, or if 40 (or less) per cent of our group have a score less than the mean standard score, then our group may be considered inferior. A difference of less than 10 per cent (50-40, or 60-50) is not very significant. This method has its statistical limitations, but the ease with which it can be applied and its approximate accuracy make it a valuable method for comparing groups.

(1) To compare a class with a standard norm (or another group) determine the percentage of the class that equals or surpasses the central tendency (mean or median) of the group with which you are making the comparison. (2) Also give the central tendency and (3) the measure of variability (Q., M.D., S.D.) of both groups. (4) The range of the distribution of both groups and the 25-percentile and the 75-percentile also are significant. (5) Another method is to represent graphically the distribution of the group in which our interest lies and then by

[1] See pp. 207-209 for these measures of variability.

colored vertical lines erected on the x-axis indicate the mean or median of both groups. Constructing graphs for both distributions, and then superimposing one graph upon the other, involves a statistical procedure too difficult to discuss here. Since the authors of standard tests commonly give only the mean or median, the first and last methods are the ones most likely to be of value.

Procedure.—Study the above discussion and where necessary refer to pages 196-209 for an understanding of the statistics. Answer and solve the problems and questions given below.

QUESTIONS

1. Compare the following groups as to ability in spelling:

Group I.....Mean spelling score, 55, Q. 12
Group II.....Mean spelling score, 55, Q. 7

2. Compare Group II with Group I as to ability in arithmetic:

Group I.....Median score, 10.5

Distribution of Group II

Number of Problems Correct	*Frequencies*
6– 6.99	2
7– 7.99	4
8– 8.99	5
9– 9.99	8
10–10.99	9
11–11.99	7
12–12.99	3
13–13.99	3
14–14.99	1

Median of Group II?

Percentage[2] of Group II, equaling or surpassing median of Group I = ?

3. Graphically represent the distribution of Group II set forth in Problem 2. Indicate upon this graph in different colored inks the medians of Groups I and II.

[2] How many of the 9 pupils in the interval, 10–10.99 have scores equal to or greater than 10.5?

REFERENCES

RUGG, Harold, *Statistics Applied to Education*, pp. 149-154.
STARCH, Daniel, *Educational Psychology*, pp. 65, 66.
THORNDIKE, Edward, *Mental and Social Measurements*, Ch. xix.

EXPERIMENT 49[1]

FEELING

Object.—*To study the effects of feeling upon the accuracy and rapidity of work.*

Material.—Watch with second hand; powdered alum, or some similar harmless and unpleasant substance; sweet, powdered chocolate, or some similar pleasant substance. (Odors may be substituted.)

Procedure.—The Instructor will divide the class into three groups, designating them as Group I, Group II, and Group III. All groups are to read the general directions. Group I will then perform the experiment in the order of the directions for Trials A, B, and C; Group II will perform the experiment in the order of the directions for Trials B, C, and A; and Group III will perform the experiment in the order of the directions for Trials C, A, and B.

GENERAL DIRECTIONS

You will be expected to add 17 to the number[2] given to you by your Instructor, and to continue thereafter to add 17 to the sum secured by each addition. Place the sums, for purposes of record, upon paper, but immediately

[1] To be performed after the study of a textbook account of the subject.

[2] For each of the three trials take a different one of the following numbers: 4, 6, 7, 8, 9. The students are advised not to practice the addition.

look away from this sum before mentally making the next addition. The Instructor will say, "Stop!" at the end of one minute.

DIRECTIONS FOR TRIAL A

You are to perform the experiment as set forth in the general directions. Do not read the next set of directions assigned you until directed to do so. The Instructor will say, "Ready! The number is —. Go!"

DIRECTIONS FOR TRIAL B

You are to perform the experiment as set forth in the general directions with the following additions: You are to obtain a pinch of sweet powdered chocolate, and when the Instructor says, "Ready!" place the chocolate upon your tongue. Do not swallow it, but let it dissolve slowly. The Instructor immediately will say, "The number is —. Go!" Do not read the next set of directions assigned you until directed to do so. Be certain that the taste of chocolate has disappeared completely before beginning the next part of this experiment.

DIRECTIONS FOR TRIAL C

You are to perform the experiment as set forth in the general directions with the following additions: You are to obtain a pinch of powdered alum, and when the Instructor says, "Ready!" place the alum upon your tongue. Do not swallow it, but let it dissolve slowly. The Instructor immediately will say, "The number is —. Go!" Do not read the next set of directions assigned you until directed to do so. Be certain the taste of alum has disappeared completely before beginning the next part of this experiment.

Obtain the number of correct answers for each of the three trials. Count as correct any sum that is the result of correctly adding 17 to the preceding number, whether

or not that number be the result of the correct addition of 17 to the number preceding it. Label three blackboards A, B, and C, and let each student place his scores on the proper blackboard so that the entire class can obtain them. What are the total scores (not the means) for each trial?

QUESTIONS[2]

1. Which of the three trials gave the highest total number of correct additions? How does Trial B compare with Trial C? How do you explain this?

2. If simple sensations and the resulting *feelings* of pleasantness and unpleasantness affect the quality and quantity of work, what effect has cheerfulness upon work? Discouragement?

3. Visit several elementary grades for the purpose of observing and noting the spirit of the schoolroom. In those classes where strict order is maintained and the children's spontaneity is suppressed, note whether the children's attention is due to interest, sense of duty, fear, etc. Contrast such a class with a class in which the atmosphere is pleasant and the children are happy. Which of the two classes do you believe accomplishes the better and more lasting work? Which class would you prefer to teach? Why?

4. Why is the spirit in the schoolroom all important in affecting the effort, disposition, learning ability, etc., of pupils?

REFERENCES

BETTS, G. H., *The Mind and Its Education*, Ch. xvi.

See also references at end of Experiment 50.

EXPERIMENT 50[1]

EMOTIONS

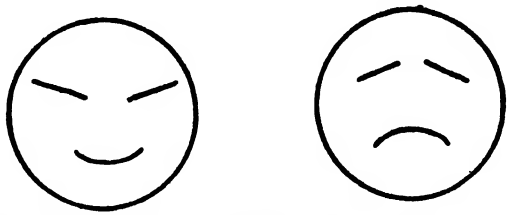
Object.—*To investigate the physical expressions accompanying the emotional states.*

[2] See also questions in Betts, *The Mind and Its Education*, p. 289.

[1] To be performed after the study of the textbook account of the subject.

Material.—(*A*) one picture depicting sadness and grief; (*B*) one picture depicting a landscape scene; (*C*) one picture depicting joy and happiness.

Procedure, I.—Leonardo da Vinci (1452-1519) presented the facial expression of two opposite emotions as in the accompanying figures.[2]



Study these figures and answer the following questions:

QUESTIONS

1. What emotions are expressed by these two figures?[3] Can you give any reasons for them being expressed as they are?

2. Describe the facial expressions and gestures evident in two emotional states other than those depicted above.

3. What appear to be the characteristic internal bodily expressions in a state of fear? Anger? Jealousy? Hatred? Love? Grief? Select two of these emotional states, and describe the bodily characteristics as well as you can from your own introspections.

4. What is the significance of the bodily expressions? (Betts, *The Mind and Its Education*, p. 292.)

Procedure, II.—Act out the emotions of grief and joy by facial expressions.

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[2] Adapted from Titchener, *A Primer of Psychology*, p. 159.

[3] See Antoinette Feleky in the *Psychological Review*, Vol. 21 (1914), pp. 33-41, for pictures of facial expressions evident in various emotions. The pictures are obtainable from C. H. Stoelting & Co., Chicago.

QUESTIONS

1. Do you actually experience these emotions? If so, indicate whether these emotions have the same quality as the actual emotions?

2. If you are angry, but consciously strive to substitute a smile, relax muscles, etc., for the knitted brow, tense muscles, etc., what effect does this have upon the emotional state? Answer this question from your own experience.

3. Why does one whistle when he is afraid? What is the psychological effect of this whistling upon the emotion of fear?

4. How may we control the following emotions of children: fear of dogs and grief over some broken toy? What general rules can you suggest for controlling the emotional life of the child?

5. Do you study better when you are happy and satisfied, or unhappy and irritated? What do you conclude as to the emotional attitude that should exist in the schoolroom?

6. Observe several children for a period of not less than a week and try to estimate the quality of their prevailing moods. What bearing will this have on their disposition and character?

Procedure, III.—If we were to present a picture to a group of children and ask them to make a statement concerning it, our results would be of little psychological value as far as an investigation of the emotional appeal of the picture is concerned. The children would be unable to report introspections accurately or they would try to please us with the answers they thought we wanted. Instruments[4] can be obtained for investigating and recording the effects of emotional appeals upon the pulse and breathing rates, but they are too complicated for our study. Therefore we must use an indirect and somewhat less accurate method for our investigation.

Let each student act as an Examiner and present picture

[4] See R. Schulze, *Experimental Psychology in Pedagogy*, Ch. v. Translated by Rudolph Pintner.

A to a child of about 12 years of age. Say to the child, "I am going to show you a picture for ten seconds and I want you to look at it and see if you like it." Before presenting the picture, note and briefly describe the position of the child's hands and facial expression. When the picture is presented note and briefly describe any changes evident in the position of the hands, facial expression, also note whether the child utters any exclamation which might give evidence of the effect of the picture upon him. Allow an interval of several minutes to elapse before presenting the next picture; during this interval engage the child in conversation about his lessons or play in order to distract his thought from the picture just shown him. Present pictures *B* and *C* in a manner similar to *A*.

Again present picture *A* to the child and say, "When I look at this picture, I feel that I know what the people are thinking. What do you believe they are thinking?" Then, after the child tells what he believes they are thinking and you have briefly recorded it, ask the child (if he has not already given the reasons), "Why do you believe they are thinking this?" For picture *B*, say to the child, "When I look at this picture for a time, I see people. What sort of people do you think I see, and what do you think they are doing?" Present picture *C* with the same questions as used for picture *A*.

Questions

1. Analyze your descriptions of the facial expressions and positions of the hands of the child when the three pictures were presented to him. Are there evidences of an emotional response to the pictures? What emotions seem to be present? Do the verbal responses of the child tend to verify your analyses?

2. Does the child seem to understand and appreciate the pictures? What reasons can you give for your answer?

3. Why does the advertising man depict in his advertisement

people with happy, smiling, and satisfied faces? Why do we place cheerful pictures in children's bedrooms?

4. Think over the list of persons you like best. Then try to describe the emotional quality of each. To what extent do you think the emotional aspect of personality figures in what we call personal charm?

5. Describe two cases in which the same mental state is paralleled by different movements. Describe two cases in which the same movement or movements are paralleled by different mental states.

References

Betts, G. H., *The Mind and Its Education,* Ch. xvii.
Averill, E. A., *Psychology for Normal Schools,* Lessons 19-21.
Cameron, E. H., *Psychology and the School,* Ch. x.
Coffin, *How to Study Pictures.*
Colvin and Bagley, *Human Behavior,* Chs. v, vi.
Hurll, E. M., *How to Show Pictures to Children.*
James, William, *Psychology, Briefer Course,* Ch. xxiv.
La Rue, D. W., *Psychology for Teachers,* Ch. xiii.
Norsworthy and Whitley, *Psychology of Childhood,* Ch. v.
Woodworth, R. S., *Psychology,* Ch. ix ("The Feelings"), Chs. vii, viii ("Emotions").

EXPERIMENT 51

Doctrine of Formal Discipline: The Transference of Training

Object.—*To determine whether or not training in one mental trait improves abilities in other mental traits.*

Many people claim that a school subject is valuable not only for its content but also for the mental powers it develops. For example, a study of formal grammar is supposed to give one the power to reason, and this power to reason is supposed to carry over not only to all other school subjects but to the activities of life itself. This doctrine of formal discipline maintains that the mental discipline gained from the study of school subjects

carries over to all activities. No educational theory has ever exerted the profound influence upon curricula-making and methods of teaching as this doctrine has done, and it is therefore fitting that we experimentally study it. However, the problem we have set ourselves is a difficult one. Hence we can only begin in a very elementary fashion to attack it; the student then will find the numerous investigations in this field more intelligible to him.

An inspection of the material on the following pages will invalidate the experiment; therefore, always keep this material covered except when directed to use it.

We shall attack the problem by testing ourselves in a certain mental trait such as auditory memory span (see Experiment 41), and then shall discipline ourselves by a training in some other trait such as memorizing a Dutch-English vocabulary, and finally shall test ourselves in memory span to see if we have improved in this trait. Such material as the Dutch-English vocabulary is known as the practice or training series, whereas the memory span material is known respectively as the first-end test and the second-end test. If we know that in the first-end test we have a memory span of 7 digits, and after the practice we have a memory span of 9 digits, we have shown an improved ability of 2 digits, or 29 per cent. But how do we know that some improvement did not take place as a result of the practice in the end-tests themselves? We do not know! Therefore, we need a *control group* in order to isolate the improvement resulting from the practice series. We do this by giving a large group of individuals the first-end test, and on the basis of this test we divide the group into two smaller groups so that each half is of equal ability in the trait. One group is known as the *control group* and the other as the *training*, or *practicing group*.

The control group takes only the two end-tests, and the practicing group takes all of the tests. Now if the practicing group improves two memory-span digits, on the average its apparent improvement is 29 per cent, provided the first-end test gave an average span of 7 and the second-end test gave an average span of 9. But the 29 per cent improvement is not due to the practice series alone; we need to consider the control group. Let us

suppose that the first-end test showed an average span of 7 digits, and the second-end test an average span of 8 digits. The improvement for the control group is therefore 14 per cent. The difference between the improvement of the practiced group (29 per cent) and the improvement of the control group (14 per cent) gives us the amount of improvement due to the practice or training series. In this case the transfer of training due to the practice series is 29 — 14, or 15 per cent.

Procedure, I.—The Instructor will divide the class so that one half of the students are in the practice group and the other half in the control group. Correct scientific procedure requires that the two groups be equal in ability in the first-end tests, but this requirement can not be very well fulfilled in an elementary experiment of this sort; we can only hope to approximate the requirement. It is imperative that the control group does not refer to the training tests during the interval between the two end-tests.

The end-tests will be: (1) auditory memory span (Experiment 41), (2) the learning of a Norwegian-English vocabulary, (3) the memorizing of a stanza of poetry. The practice series will consist of learning a Dutch-English vocabulary.

First End-Tests

(1) The auditory memory span is to be given by the Instructor to both the practicing and control groups according to the directions set forth in Experiment 41. The score is to be obtained as set forth in this experiment.

The digits to be used appear upon page 177.

(2) The following Norwegian words and their English equivalents are to be learned by both groups. Learn the list by the whole method[1] (see Experiment 25) that is, by going through the list from beginning to end until the

[1] In actual practice one would not learn the vocabulary in this manner.

6 3 8 1 4
2 5 3 9 7
9 6 8 2 5 3
5 7 1 8 4 6
7 2 5 3 6 8 4
3 6 4 1 7 2 5
4 8 1 5 2 9 3 6
2 7 5 9 3 1 4 8
6 2 8 4 7 3 1 9 5
7 1 9 6 4 5 3 8 2
3 5 9 7 1 4 8 2 6 1
6 8 2 5 1 3 9 2 4 7

list is known. Expose one pair of words at a time, first exposing the Norwegian word, then the English equivalent. Consider the list learned when you are just able to go through the list once without an error. Keep a record of the repetitions necessary to learn the words.[2]

NORWEGIAN-ENGLISH VOCABULARY

husk.....remember
ansigt.....face
taalmodige.....patient
egne.....own
stemme.....voice
fattigdom.....poverty
gutten.....boy
spise.....eat
pene.....pretty
aldrig.....never

[2] The time necessary to learn the list would be a better measure than the repetitions, and, if it is found possible, the time measure should be adopted. But an Experimenter is usually able to record by himself the repetitions necessary to learn material while he is unable to record the time accurately.

(3) The following stanza of poetry is to be learned by both groups, according to the whole method (see Experiment 25). Consider the stanza as learned when you are just able to go through it once without an error. Keep an accurate record of the repetitions necessary to learn the stanza.

Love, always impatient of doubt or delay,
Now sighed for the aid of the favoring gales,
And scolded at Time, in the sauciest way,
For not having furnished the shallop with sails.[3]

Practice Series

The practice series which follows are to be learned only by the training group and *not* by the control group. The practice series are divided into four groups, one of which is to be learned on four successive days. Try to learn the groups at approximately the same hour each day. Learn the groups by the whole method and consider each group as learned when you are just able to go through it once correctly. Keep a record of the number of repetitions necessary to learn each group.

It is imperative that the control group refrain from looking at or studying the practice series. Many experiments, performed in the field of transfer of training, have been invalidated either because of the absence of a control group or the practice of allowing the control group to become familiar with the material used in the training series. The absence of a control group, as previously stated, often results in a transfer greater in amount than the true transfer,[4] while the failure to keep the control group ignorant of the training material tends to reduce the true amount of transfer.

[3] Selected from John G. Saxe's "The Old Man's Motto."

[4] See criticism of such an investigation, Starch, *Educational Psychology*, pp. 201-203.

DUTCH-ENGLISH VOCABULARY

Group I

dagblad .....newspaper
gasthuis .....hospital
laag .....bed
beeld .....statue
ongoed ill
deelen .....divide
eend .....wild duck
roer .....rudder
aaming .....draught
reden .....to reason
nataal .....slander
bedwingen .....to overcome
kraelt .....strength
hiuf .....cap
aandenken .....remembrance

Group II

daad .....action
eenig .....only
gloed .....fire
chaconne .....dance
lederen .....to injure
aandacht .....attention
baldadig .....wanton
schedel .....scull
ondaad .....crime
nood .....poverty
dege .....bravely
begieten .....to wet
knol .....turnip
heijen .....to run
aandrift .....impulse

Group III

conto .....account
fnuiken .....to confute
lijmen .....glue
bakeren .....to swaddle
peen .....carrot
weer .....defend
eeuw .....century
verkoop .....sale
aandeel .....share
schoef .....collar
meineed .....perjury
bekeerd .....converted
kapel .....butterfly
inloop .....entrance
aboleien .....abolish

Group IV

colporteur .....peddle
falie .....mantle
mand .....basket
bakkes .....face
perser .....squeeze
tergen .....provoke
draven .....trot
redden .....rescue
aandraven .....to run
spek .....bacon
nadruk .....counterfeit
billijk .....equitable
kantoor .....office
invloed .....power
abonnement .....subscription

Second End-Tests

The second end-tests are to be learned by both the control and practice groups. The directions for administering and scoring these tests are the same as for the first end-tests. The material for the second end-tests follows:

1. Auditory Memory Span

4 6 1 8 3
7 5 3 6 9
2 7 9 4 8 5
5 9 1 8 6 2
6 4 8 3 5 7 1
9 2 5 3 1 4 6
2 6 8 1 7 9 3 5
7 9 3 8 2 4 1 6
3 7 9 8 2 6 4 1 5
6 5 3 7 4 1 9 2 8
5 1 3 7 9 1 4 6 2 8
7 9 2 5 3 1 8 2 4 6

2. Norwegian-English Vocabulary

arve .....inherit
penge .....money
menneskene .....people
hvorledes .....how
tung .....heavy
flinke .....smart
pige .....girl
dukken .....doll
hviske .....whisper
gulvet .....floor

3. Stanza

Love, vexed at the heart, only clamored the more,
And cried, "By the gods! in what country or clime
Was ever a lubber who handled an oar
In so lazy a fashion as old Father Time!" [4]

Work out from your own data the percentage of improvement (or otherwise) in the second end-test over the first end-test. If you were in the training group, work out the percentage of improvement evident in learning the last group of Dutch-English words over the first group. Obtain the results of all of the members of the class and use tables similar to the following ones for your records.

Personal Record

	First End-Test	Second End-Test	Percentage of Gain or Loss Second End-Test over First End-Test
1. Digits	No. digits 7	8	+ 14.0
2. Norwegian-English Vocabulary	Repetitions 24	15	+ 37.5
3. Stanza	Repetitions 9	10	— 11.1

Percentage of Gain or Loss for Individuals Comprising the Control Group

Names	Digits	Norwegian-English Vocabulary	Stanza
1			
2			
3			
4			
Etc.			
Mean Percentage *			

* In deriving the mean obtain the Σm algebraically (see p. 203).

[4] Selected from John G. Saxe's "The Old Man's Motto."

PERCENTAGE OF GAIN OR LOSS FOR INDIVIDUALS COMPRISING THE PRACTICE GROUP

Names	Digits	Norwegian-English Vocabulary	Stanza
1			
2			
3			
4			
Etc.			
Mean Percentage *			

PRACTICE GROUP:. DUTCH-ENGLISH VOCABULARY

Names	Repetitions Necessary to Learn Groups				Percentage of Gain or Loss Group IV over Group I
	1	2	3	4	
1					
2					
3					
4					
Etc.					
Mean Percentage *					

* In deriving the mean obtain the Σm algebraically.

PERCENTAGE OF IMPROVEMENT IN VARIOUS TRAITS

	Mean Percentage Gained by Practice Group	Mean Percentage Gained by Control Group	Percentage of Transfer Due to Training Series *
Digits	—	—	—
Norwegian-English Vocabulary	—	—	—
Stanza	—	—	—

* Obtained by subtracting percentages in column 3 from column 2.

To obtain the percentage of improvement in the various traits due to the training gained from learning the Dutch-English vocabulary subtract for each trait the gain (if

there be a gain) in the first end-test from the gain in the second end-test, and record these data in a table similar to the above one.

Questions

1. What are the actual percentages of improvement in the three traits—memory span, the learning of the Norwegian-English vocabulary, the memorizing of poetry—as a result of the training gained from the learning of the Dutch-English vocabulary? Why was a control group necessary?

2. Compare the actual amount of improvement in the three traits, comprising the end-tests, with the improvement evident in the fourth group of the practice series over the first group. What end-tests resemble more closely the practice series? Was the transfer greater where the resemblance was closer? If so, how much greater?

3. As a result of your answer to the previous question, what general principle can you give concerning the explanation of how transfer takes place?

4. Do the theories of Thorndike (the theory of identical elements) and Judd (the theory of generalization) conflict in their attempt to explain the transfer of training, or do they supplement each other?[5]

5. What light does this experiment throw upon the transfer values (the mental discipline) of school subjects? If one teaches a subject correctly, does he need to give constant attention to the mental disciplinary qualities of the subject, or will these qualities naturally follow as a by-product? Why?

6. Should arithmetic aim chiefly to give "mental training" or efficiency in the use of numbers? Be sure to explain and defend your answer. Apply the same test to the subject of grammar.

References

Averill, L. A., *Elements of Educational Psychology,* Lesson 16.
Cameron, E. H., *Psychology and the School,* Ch. xiii.
Colvin, S. S., *The Learning Process,* Chs. xiv, xv, xvi.

[5] See Starch, *Educational Psychology,* pp. 213-216.

FREEMAN, F. N., *How Children Learn,* Chs. viii-xi.
STARCH, Daniel, *Educational Psychology,* Chs. xiii, xiv.
THORNDIKE, Edward L., *Educational Psychology, Briefer Course,* Chs. x-xviii.

EXPERIMENT 52[1]

NEGATIVE TRANSFER OF TRAINING

Object.—*To determine whether negative transfer of training is possible.*

Material.—The same edition of a newspaper for each student; a watch with second hand.

Procedure.—The Instructor will give the entire class the following test, which is to take exactly 30 seconds. "Look at column . . . on page . . .[2] of the newspaper and beginning with the first word in the first paragraph cross out all of the *e*'s and *f*'s, both small and capital letters, occurring in that column. Work as rapidly and as accurately as you can until the word is given to stop. Ready! Go!" After 30 seconds give the signal to stop, and then have each student count the number of *e*'s and *f*'s crossed out accurately. Do not bother to take account of omissions or errors. On the basis of this test divide the class as nearly as possible into two groups of equal ability (that is, the ability to cross out the *e*'s and *f*'s correctly). Designate one group as a control group and tell them not to think of or practice the crossing out of letters. Direct the other group, that is, the training group, to practice for five successive days, at the same time each day, the crossing out of all the *b*'s and *p*'s occurring in a newspaper. The practice is to cover exactly three minutes each day. Urge

[1] To be performed after the entire completion of the previous experiment.

[2] Instructor will need to select the column and page.

the students to aim for accuracy and rapidity. The training group need not keep a record of their work, nor necessarily use the same newspaper.

After the training series has been completed, again have the control and practice groups cross out the *e*'s and *f*'s occurring in a different article in the newspaper first used. Be certain that this newspaper is not used for the training series. Have each student determine whether or not he crossed out within the 30 seconds more *e*'s and *f*'s in the second test than the first. Express this data in percentages.[3] Then have each student obtain the percentages of gain or loss of all of the students comprising first the practice group and then the control group.

Questions

1. Which group, the practice or the control group, gained more in the ability to cross out *e*'s and *f*'s? Why?

2. Of what, if any, educational significance is the possibility of negative transfer from one subject to another?[4]

3. When is the study of one language likely to interfere with the progress of another language, when one language is entirely new and the other very well known, or when both languages are entirely new? Why?

References

See references at end of Experiment 51.

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[3] In all probability the second article, that is, the second end-test will contain about a similar number of *e*'s and *f*'s. If not, the experiment is of little value.

[4] The Instructor may need to warn the students not to generalize too much about this experiment. The chief purpose of the experiment is to indicate the possibility of negative transfer.

STATISTICAL TREATMENT OF EDUCATIONAL MEASURES

STATISTICS[1]

This brief survey of statistical method is planned for the elementary student of the subject. Many topics, for example, mean deviation and standard deviation, which usually are included in elementary treatises, are referred to only for the purpose of enabling the student to understand and interpret these measures and not to enable him to obtain them. The quartile deviation, however, is described and in most elementary work can be used as a measure of variability instead of the mean or standard deviation.

Psychological or educational data must first be collected and tabulated before these data can be interpreted. The human mind cannot view or interpret all tabulated data because of their complexity; hence the data need to be condensed somewhat further. This may be done (1) by graphically representing the data; (2) by selecting the measure about which the greatest number of measures cluster, that is, the *average;* (3) by obtaining the measure which indicates to how great an extent the measures spread out from the average or cluster about the average, that is, the measure of *variability.* Frequently we need to determine how one type of ability is related to another; for example, we may need to know whether or not the ability to think in

[1] For a more complete but elementary discussion of statistics see Gregory, *Fundamentals of Educational Measurement,* or Hines, *A Guide to Educational Measurements.* For a more advanced and complete discussion of statistics see Rugg, *Statistical Methods Applied to Education;* Thorndike, *Mental and Social Measurements;* Kelly, *Statistical Method.*

terms of visual images also indicates in the greater number of cases an ability to think in terms of auditory images. To solve such a problem we need a measure of relationship, that is, the *coefficient of correlation.*

The meaning and significance of statistics will be greater if one studies the various methods and concepts as the need for them arises. The experiments in this manual refer by footnotes to the various statistical methods as they are needed.

The Tabulation of Data: the Frequency Distribution

A teacher has given an arithmetic test, which contains 20 examples, to her class. The principal has requested the results of this test which has also been given to all the same grades in the city school system. What is the best method for the teacher to follow in presenting this material? The teacher's interest is in the individual pupils, but the prin-

The teacher's record may read:

Name of Pupil	Problems Correct	Name of Pupil	Problems Correct
C. A.	9	I. M.	11
E. B.	12	C. N.	14
G. C.	11	H. N.	11
L. D.	11	J. P.	10
A. E.	5	H. P.	16
S. E.	13	W. R.	10
K. F.	10	D. S.	14
A. G.	11	E. S.	11
T. H.	12	G. S.	15
F. H.	9	R. S.	11
M. H.	13	N. T.	9
B. K.	11	K. T.	12
V. L.	14	F. W.	12
B. M.	8	P. W.	11
D. M.	12	T. Z.	10

cipal's interest, because of his administrative duties, is more often centered in groups, classes, and pupils in general. Therefore the principal does not need the names of the pupils, but simply needs the data which must be tabulated so that their meaning can be easily comprehended.

The teacher's reaction to these data would undoubtedly be the *grouping* together of those pupils who had the same number of problems correct, or, as the statistician would say, the classification and tabulation of the data in a *frequency distribution.* How is this done? First, what is the least number of problems answered correctly, the greatest number of problems answered correctly? Five and sixteen respectively. We are now ready for our first rough classification:

Number of Problems Correct	Number of Pupils	Frequency (*f*)
5	1	1
6		0
7		0
8	1	1
9	111	3
10	1111	4
11	~~1111~~ 1111	9
12	~~1111~~	5
13	11	2
14	111	3
15	1	1
16	1	1
		Total 30

What does "5" mean in the first column? Does it mean exactly 5 and no less or no more than 5? No. It simply means that the pupil worked 5 examples correctly and may or may not have been working on a sixth example when the teacher said "Stop!" Therefore, 5 means at least 5 but not 6. We state this briefly in this manner: 5.0–5.99. Likewise, for all the other figures in the first column: 6.0–6.99, 7.0–7.99, 8.0–8.99, etc. If 5 meant exactly 5 and 6 meant

exactly 6, etc., we should call the series of measure *discontinuous;* if 5 means 5.0–5.99, etc., as we have taken it, we call the series of measures *continuous.* Practically all the data one must consider in psychology and education are continuous. With these statements in mind our first rough classification becomes:

FREQUENCY DISTRIBUTION

Class Interval	Frequency (f)
5– 5.99	1
6– 6.99	0
7– 7.99	0
8– 8.99	1
9– 9.99	3
10–10.99	4
11–11.99	9
12–12.99	5
13–13.99	2
14–14.99	3
15–15.99	1
16–16.99	1
	$n=30$

It will be noted that f is the symbol used to refer to frequency and that n refers to the total number of measures, that is, cases or pupils.

Grouping of measures in a frequency distribution. Let us suppose that instead of 30 pupils we had 245 who had been given 100 examples, all of the same difficulty. We now need to express the series or class intervals in terms of percentages instead of number of problems correct. To make provision for every percentage from 0 to 100 would entail too much labor; hence we make the class interval as large as we deem necessary to reduce the labor and still obtain an accurate representation of the data. For example, we might have as our intervals 0–4.99, 5–9.99, etc.,

or 0–9.99, 10–19.99, etc., or any other interval which we might desire. Let us first select the interval of 5 units, then the interval of 10 units; the frequency distributions for these intervals follow:

DISTRIBUTION OF 245 SIXTH-GRADE PUPILS IN 100 ARITHMETIC PROBLEMS

Class Intervals of 5 Units

Class Interval	f
0– 4.99	0
5– 9.99	0
10–14.99	1
15–19.99	2
20–24.99	2
25–29.99	3
30–34.99	3
35–39.99	5
40–44.99	6
45–49.99	14
50–54.99	22
55–59.99	29
60–64.99	24
65–69.99	36
70–74.99	35
75–79.99	31
80–84.99	13
85–89.99	10
90–94.99	7
95–100	2
	$n=245$

In many of the problems one meets in psychology and education it is advisable to use class intervals of more than one unit. A class interval of one unit usually permits obtaining more accurate averages, measures of variability, etc., but the amount of labor saved by the larger intervals more than compensates for the slight inaccuracies which result from the larger intervals. The larger the number of

DISTRIBUTION OF 245 SIXTH-GRADE PUPILS IN 100 ARITHMETIC PROBLEMS

Class Intervals of 10 Units[1]

Class Interval	*f*
0– 9.99	0
10–19.99	3
20–29.99	5
30–39.99	8
40–49.99	20
50–59.99	51
60–69.99	60
70–79.99	66
80–89.99	23
90–100	9
	n=245

units included in one class interval, the fewer will be the class intervals in the distribution. Only experience will aid you to determine the size of the interval, but arbitrarily we may suggest that one should never condense the distribution to less than 20 or 15 intervals. If, for example, the range (the lowest and highest measures) is from 0 to 100, a class interval of 5 units will give 20 intervals; if the range is from 0 to 75, a class interval of 5 would give 15 intervals, and a class interval of 4 units will give 19 intervals (making the last class interval 72–75.99).

In stating that 5 problems (see p. 191) really means 5–5.99, we indicate that there is no break between 5 and 6, but that the measures are *continuous*. The student will understand this concept somewhat better if he will graphically represent a distribution as a scale. For example:

[1] See comments below indicating inadvisability of reducing the number of intervals below 15.

Class Interval	Scale	
5– 5.99	5	1
6– 6.99	6	0
7– 7.99	7	0
8– 8.99	8	1
9– 9.99	9	3
10–10.99	10	4
11–11.99	11	9
12–12.99	12	5
13–13.99	13	2
14–14.99	14	3
15–15.99	15	1
16–16.99	16	1
	17	

$n=30$

Class Interval	Scale	f
0– 9.99	0	0
10–19.99	10	3
20–29.99	20	5
30–39.99	30	8
40–49.99	40	20
50–59.99	50	51
60–69.99	60	60
70–79.99	70	66
80–89.99	80	23
90–100	90	9
	100	

$n=245$

Viewing the distribution as a scale will enable the student to realize that the measures are continuous. We frequently need to represent the class interval by one value; this causes us to call attention to a fundamental assumption underlying the theory of grouping measures in class intervals. This assumption is that the measures in any class interval are uniformly distributed in that interval, and the mid-point best represents the interval. For example, the mid-points of the class intervals 0–4.99, 5–9.99, etc., are, respectively, 2.5, 7.5, etc.; of class intervals 0–9.99, 10–19.99, etc., respectively, 5, 15, etc.

Graphic Representation of the Frequency Distribution

The frequency distribution lends itself to interpretation somewhat better than the ungrouped measures. The graphic representation of the data presented in a frequency distribution increases the possibilities of interpretation. We shall describe the two most important methods[3] of graphically representing the frequency distribution: (1) the *histogram,* or the *column diagram,* and (2) the *frequency polygon.*

Graphing, that is the plotting of a distribution, will be much easier if the student uses quartile paper. Following the algebraic methods of graphing, let the horizontal line OX represent the x-axis and the vertical line OY represent the *y-axis* (Fig. 11). Note the range (the lowest and highest measures) of the distribution to be plotted and the total number of frequencies. The score values (class intervals) are represented from left to right on the x-axis, and the frequencies are represented from the bottom to the top on the y-axis. Plan to represent one class interval by one or more divisions (never fractional parts), and represent the frequencies by fractional parts, or one or more divisions.

[3] See Experiment 38, Question 2, for an additional method.

Experience will aid you in this planning; try to plan the graph so that it will be fairly large and sym-

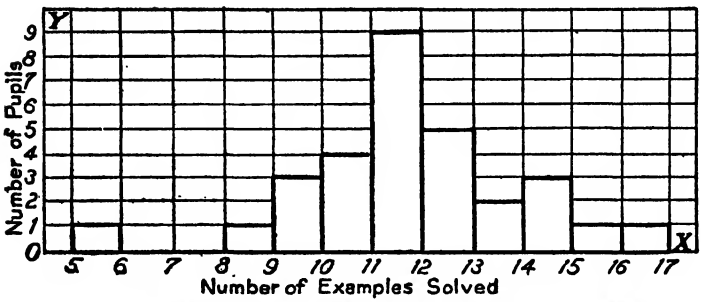

FIG. 11.—COLUMN DIAGRAM BASED ON DISTRIBUTION GIVEN ON PAGE 192.

metrically placed upon the paper. Let us represent the distribution given on page 192 by the column diagram (Fig. 11).

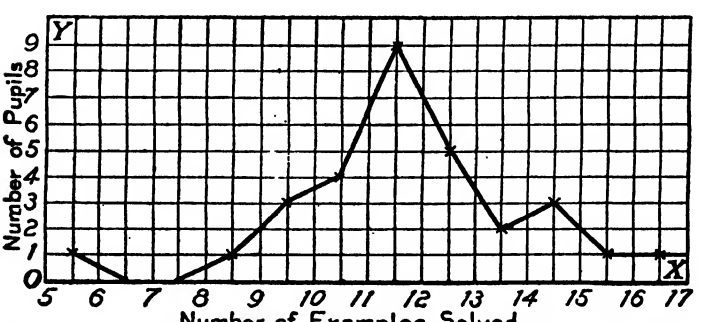

FIG. 12.—FREQUENCY POLYGON BASED ON DISTRIBUTION GIVEN ON PAGE 192.

Take the first class interval 5–5.99, and at 6 draw a vertical line from the x-axis, and then, at the proper frequency 1, draw a horizontal line from the y-axis until it intersects the line just drawn from the x-axis. The column

thus constructed indicates that one pupil had a score which placed him in the class interval 5-5.99. The other columns are constructed in a similar fashion.

Let us represent the same distribution by the frequency polygon (Fig. 12). We must now keep in mind that the mid-point of an interval (in this case 5.5, 6.5, etc.) best

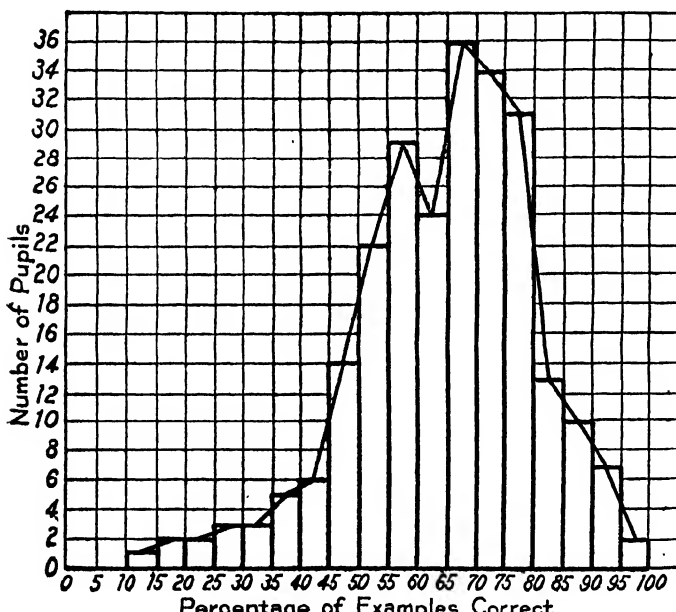

FIG. 13.—COLUMN DIAGRAM AND FREQUENCY POLYGON OF THE SAME DISTRIBUTION.

represents the whole interval. At the mid-point of each interval erect an imaginary vertical line and also erect an imaginary horizontal line at the proper frequency. Where these imaginary lines intersect, make a dot or a small cross. Continue to do this for each class interval and its frequency; remember that when the frequency is 0 the dot is

made on the x-axis. Join these dots by straight lines, and you will have the frequency polygon.

When the class interval has more than one unit, the same general principles just described are followed in plotting the graph. The column diagram and frequency polygon (one superimposed upon the other) for the distribution given on page 193 are shown in Fig. 13.

The Method of Averages

We have so far considered the tabulation of data and the graphic representation of the frequency distribution. We still need a method that will condense our original data into one measure so that we can at least describe with fair accuracy a distribution of measures. The measure that best represents a distribution is the value about which all the distribution tends to center, that is, the central tendency. There are three central tendencies, or averages:[4] (1) the *mode;* (2) the *median;* and (3) the *mean.*

The mode. The *mode* is that value in the distribution that occurs most frequently. The mode is commonly referred to as the "inspection" average, because by inspecting the frequency distribution, or frequency polygon, it is possible to determine the value that occurs most frequently. This central tendency is very crude, and the student is advised not to use it except to aid him in determining the class interval in which the true mean [5] probably falls.

The mode for the distribution given on page 192 is 11.5, that is, the mid-point of the class interval that has 9 frequencies; the mode for the distribution given on page 193 is 67.5, that is, the mid-point of the class interval that has 36 frequencies. Inspection of this last distribution will make clear the crudeness of the mode as a measure

[4] The term average is often used to refer to the arithmetic mean.

[5] See the discussion of the mean below.

of central tendency, for the value 72.5 has a frequency of 35, only 1 less than 36. Again note that the mode of the distribution given on page 194 (this distribution differs from the previous one in that the class intervals have 10 instead of 5 units) is 75, since it is the mid-point of the class interval that has 66 frequencies. This shows that the mode is often influenced by the size of the class interval selected.

The median. The *median* is that point on the scale on each side of which $\frac{n}{2}$ measures fall, n referring to the total number of frequencies. The median is commonly referred to as a "counting" average, since it is obtained by first arranging the measures in a frequency distribution and then counting so as to find the point on the scale which has $\frac{n}{2}$ measures on each side of it. Bearing in mind that the measures in a scale are continuous and that the measures in a class interval are distributed uniformly throughout that interval, and furthermore that the mid-point best represents the interval, let us illustrate and describe the steps to be followed in obtaining the median of the distribution given on page 192.

$$\frac{n}{2}=\frac{30}{2}=15$$

Therefore we need a point on the scale which has 15 measures on each side of it. We begin with the smallest interval, 5–5.99 (we could begin with the largest), and add the frequencies of this interval to the frequencies of the following intervals until we obtain either a total of 15 frequencies or as near 15 as possible. Let us add the frequencies of the intervals 5–5.99 to 10–10.99 inclusive:

$$1+0+0+1+3+4=9$$

If we had added the 9 frequencies of the class interval 11-11.99, we would have had 18 frequencies, just 3 too many. But the 9 frequencies (of the class intervals 5.5–99 to 10–10.99, inclusive) are 6 too few, and hence we need 6 frequencies of the 9 frequencies of the class interval 11–11.99, that is, we need $\frac{6}{9}$ of 1 (the 1 being the number of units in the class interval of 11-11.99). We now obtain $\frac{6}{9}$ of 1 or .67. Now let us go back to the step in which we added the frequencies $1+0+0+1+3+4=9$. The ninth frequency brought us *to*, but *not into*, the class interval 11–11.99, that is, it brought us to 11. Therefore,

$$11+\frac{6}{9}\text{ of 1, or } 11+.67\text{, or } 11.67$$

is our median because on each side of it there are $\frac{n}{2}$, or 15 measures.

Let us obtain the median for this same distribution (page 192) by counting from the largest class interval in the direction of the smallest. Beginning with the interval 16–16.99, we add the frequencies of the class intervals 16–16.99 to 12–12.99 inclusive, that is,

$$1+1+3+2+5=12$$

We therefore need 15—12, or 3 of the 9 frequencies of the class interval 11—11.99. The 12 frequencies bring us to 12, but not into the next interval 11–11.99; therefore we subtract from 12 (the beginning of the class interval 12–12.99), $\frac{3}{9}$ of 1 or 0.33, that is 12—0.33, or 11.67, which is the median corresponding in size to the one we previously obtained when we began to count from the smallest class interval.

In obtaining the median never use $\frac{n-1}{2}$ instead of $\frac{n}{2}$.*

If you use $\frac{n-1}{2}$ instead of $\frac{n}{2}$ to obtain the median for the distribution given on page 192, and work from both ends of the distribution, you will find that you get two different medians, that is, 11.78 and 11.56, instead of 11.67, which we obtained in the above computations.

Let us obtain the median of the following distribution:

Class Interval	f
25–25.99	1
26–26.99	3
27–27.99	6
28–28.99	7
29–29.99	6
30–30.99	4
31–31.99	3
32–32.99	3
33–33.99	1
	$n=34$

$$\frac{n}{2} = 17$$

We need a point on the scale that has 17 measures on each side of it. We add the frequencies of the class intervals, 25–25.99 to 28–28.99, that is,

$$1+3+6+7+ = 17$$

which happens to be $\frac{n}{2}$. The median therefore is 29, because the 17 measures bring us to, but not into, the class interval 29–29.99.

Let us obtain the median of the distribution given on page 193.

$$\frac{n}{2} = \frac{245}{2} = 122.5$$

* Suggested by some textbooks.

We need a point on the scale that has 122.5 measures on each side of it. We add the frequencies of the class intervals 0–4.99 to 60–64.99, inclusive, and we get a total of 111. We need 122.5—111, or 11.5 of 36 frequencies of the class interval 65–69.99. The 111 frequencies bring us to 65; therefore

$$65 + \frac{11.5}{36} \text{ of } 5, \text{ or } 65 + 1.6 = 66.6$$

which is the median. Note that the class intervals have 5 units; hence we add $\frac{11.5}{36}$ of 5 to 65.

Let us obtain the median of the distribution given on page 194. This distribution differs from the preceding distribution in that the class intervals have 10 units instead of 5.

$$\frac{n}{2} = 122.5$$

We add the frequencies of the class intervals from 0–9.99 to 50–59.99, inclusive, and obtain 87. We need 122.5 — 87, or 35.5 of the 60 frequencies of the class interval 60-69.99. The 87 measures bring us to 60; therefore the median is

$$60 + \frac{35.5}{60} \text{ of } 10, \text{ or } 65.92$$

It will be noted that the median 65.92 is 0.68 of a unit smaller than the median 66.6 which we obtained with the class interval of 5 units. This illustrates the points referred to on page 193, that is, that the reduction of the number of class intervals below 15 tends to give somewhat less accurate central tendencies than a larger number of intervals would give.

The arithmetic mean.—The *arithmetic mean* may be defined as the sum of the values of all of the measures in the

distribution divided by the number of frequencies, that is,

$$M = \frac{\Sigma fm}{n}$$

where M is the symbol for the mean, Σ, the symbol meaning the sum of, f the symbol representing the frequencies of the class intervals, m the symbol for the individual measures, and n the symbol for the total number of frequencies.

Let us obtain the arithmetic mean of the following distribution:

Pupil	Weight, Pounds *	f	fm
A	60	1	60
B	63	1	63
C	68	1	68
D	70	1	70
E	74	1	74
F	76	1	76
G	80	1	80
H	98	1	98
		$n = 8$	8) 589
			73.625 *mean*

* The series is here considered as being discontinuous; that is, 60 means 60, etc.

Class Interval	Mid-Point of Class Interval	f	fm
5– 5.99	5.5	1	5.5
6– 6.99	6.5	0	0
7– 7.99	7.5	0	0
8– 8.99	8.5	1	8.5
9– 9.99	9.5	3	28.5
10–10.99	10.5	4	42.
11–11.99	11.5	9	103.5
12–12.99	12.5	5	62.5
13–13.99	13.5	2	27.
14–14.99	14.5	3	43.5
15–15.99	15.5	1	15.5
16–16.99	16.5	1	16.5
		$n = 30$	30)353.0
			11.767 *mean*

Since the f for each measure is 1, the fm column is unnecessary, and the mean could have been obtained by the direct application of the formula $M = \frac{\Sigma m}{n}$.

Let us obtain the mean of the distribution given at the bottom of page 204.

It will be noted when the measures are grouped in class intervals and the series are continuous, that the mid-point of the class interval is the value used in obtaining mf.

Let us obtain the mean of the distribution given on page 194.

Class Interval	Mid-Point of Class Interval	f	mf
0– 9.99	5	0	0
10–19.99	15	3	45
20–29.99	25	5	125
30–39.99	35	8	280
40–49.99	45	20	900
50–59.99	55	51	2805
60–69.99	65	60	3900
70–79.99	75	66	4950
80–89.99	85	23	1955
90–100	95	9	855
		$n = 245$	245)15815
			64.551 *mean*

The labor necessary to obtain the arithmetical mean by the formula $M = \frac{\Sigma fm}{n}$ makes desirable a shorter method for obtaining this central tendency. The short method, which is described and illustrated below, treats the class interval as a unit of 1 on the scale instead of its true value. The short method also necessitates the selection of a class interval (usually the class interval containing the mode) as the interval containing the *estimated mean;* furthermore, the short method involves the computation of the difference between the *estimated mean* and the *true mean.* Let us

apply the short method to the distribution to which we just applied the long method.

COMPUTATION OF THE MEAN BY THE SHORT METHOD

Class Interval	f	Deviation from Interval Containing Estimated Mean (d)	fd
0– 9.99	0	—7	0
10–19.99	3	—6	— 18
20–29.99	5	—5	— 25
30–39.99	8	—4	— 32
40–49.99	20	—3	— 60
50–59.99	51	—2	—102
60–69.99	60	—1	— 6 — 297
70–79.99	66	0	0
80–89.99	23	+1	+ 23
90–100	9	+2	+ 18 + 41
	$n = 245$		—256

The estimated mean is taken as 75, the mid-point of the class interval 70-79.99. The interval 70-79.99, since it contains the estimated mean, deviates to the extent of 0 from the estimated mean; the interval 60-69.99 deviates to the extent of -1 from the estimated mean; the interval 50-59.99 deviates to the extent of -2 from the estimated mean, etc., because we have treated the class intervals as units of 1 on the scale, instead of at their true value. The next step is to obtain the fd's by multiplying these deviations by the proper frequency. The

$$\frac{\Sigma fd}{n} = \frac{-256}{245} = -1.045$$

in terms of intervals taken as a unit of 1. Then

$$-1.045 \times 10 = -10.45$$

in terms of class intervals of true value, that is, 10 units.

The correction to be added algebraically to the estimated mean in order to obtain the true mean is —10.45.

Estimated Mean...	75.00	(mid-point of interval containing estimated mean)
Correction .....—	10.45	
True Mean	64.55	

The Quartile Deviation

Two frequency distributions may have approximately the same central tendency, but one distribution may be more homogeneous than the other, that is, one group may be less variable than the other. The mere statement of the *range* (the highest and lowest value in the distribution) does not suffice as an index of the variability of a group; we therefore need a measure of *variability*. There are four measures of variability: (1) the *quartile deviation;* (2) the *mean deviation;* (3) the *probable error;* and (4) the *standard deviation.* We shall consider only the method for obtaining the quartile deviation.

The formula for the quartile deviation (Q) is:

$$Q = \frac{Q_3 - Q_1}{2}$$

Q is the symbol representing the quartile deviation, whereas Q_1 represents the first quarter-point on the scale, and Q_3 represents the third quarter-point on the scale. Q_1 and Q_3 need further explanation. The median is the one-half point on the scale (Q_2), and, as we have seen by definition, it has one-half the measures in the distribution above and one-half of the measures below it. With these facts in mind the student can understand that Q_1 is that point on the scale that has three times as many measures above it as below it, whereas Q_3 is that point on the scale which has three times as many measures below it as above it.

Let us obtain the quartile deviation (Q) of the distribution given on page 193.

$$\frac{n}{4} = \frac{245}{4} = 61.25$$

Counting down from the class interval 0–4.99 to the class interval 50–54.99, we have 58 measures, just 3.25 short of the necessary 61.25. Therefore, since the 58 measures bring us to 55 (the beginning of the interval 55–59.99), we add to 55,

$$\frac{3.25}{29}\text{of } 5, \text{ or } 55 + \frac{3.25}{29}\text{of } 5 = 55.56$$

$$Q_1 = 55.56$$

Next we need to obtain Q_3.

$$\frac{3n}{4} = \frac{3 \times 245}{4} = 183.75$$

Counting down from the class interval 0-4.99 to the class interval 70–74.99, we have 182 measures, just 1.75 measures short of the necessary 183.75. Therefore, since 182 measures bring us to 75, we add to 75,

$$\frac{1.75}{31}\text{ of } 5, \text{ or } 75 + \frac{1.75}{31}\text{ of } 5 = 75.28.$$

$$Q_3 = 75.28$$

$$Q = \frac{Q_3 - Q_1}{2} = \frac{75.28 - 55.56}{2} = \frac{19.72}{2} = 9.86$$

Therefore:

$$Q = 9.86$$

The student will note that the same general procedure used to obtain the median (Q_2) is followed to obtain Q_1 and Q_3. Just as the median is a "counting" average, so Q is a "counting" deviation in that it is obtained by counting. It will be noted that 50 per cent of the cases fall between

Q_1 and Q_3. Instead of obtaining Q_3 by counting down $\frac{3n}{4}$ measures from the smallest class interval, we could count up $\frac{n}{4}$ measures from the largest class interval in the direction of the smaller intervals.

The mean deviation, probable error, and standard deviation are also measures of variability, but we cannot consider here the methods for obtaining them. Mathematically and statistically, they are more accurate and valuable than the quartile deviation, but for most of our work the quartile deviation will be sufficient. In a normal curve of distribution [7] the mean deviation, probable error, and quartile deviation are of the same size, though they are obtained by different methods. The standard deviation is always larger than the other three measures of variability. Briefly, in a normal curve of distribution, if one subtracts one standard deviation from the mean or median and adds one standard deviation to the mean or median, between the two figures thus obtained occur some two-thirds of the cases in the distribution. If, in a normal curve of distribution, one subtracts one mean deviation, or probable error, or quartile deviation, from the mean or median and adds one mean deviation, or probable error, or quartile deviation, to the mean or median, between the two figures thus obtained occur one-half of the cases in the distribution. These statements are only approximately true when the distribution is not a normal curve.

The Coefficient of Correlation

We still need to describe a method for determining whether one trait is related to another. We shall use the method of rank differences, one of the simplest methods,

[7] See Experiment 39.

although not the most accurate, for determining the relationship existing between two arrays. The relationship is expressed in the form of an index known as the *coefficient of correlation.* This index varies in magnitude from + 1.00 for perfect relationship to 0 for no relationship, then in the negative direction from 0 to — 1.00 for perfect negative correlation.

The formula for the method of rank differences is:

$$\rho = 1 - \frac{6\Sigma D^2}{n(n^2-1)}$$

Let us illustrate the application of this formula:

Pupils	Mark in Arithmetic	Rank in Arithmetic	Mark in Reading	Rank in Reading	D	D^2
A.....	92	1	95	1	0	0
B.....	88	2	80	5	3	9
C.....	84	3	92	2	1	1
D.....	82	4	90	3	1	1
E.....	79	5	70	7	2	4
F.....	74	6	85	4	2	4
G.....	70	7	75	6	1	1
H.....	68	8	65	8	0	0
I.....	65	9	60	9	0	0
$n=9$						$\Sigma D^2 20$

The problem is to determine whether or not there is a tendency for the pupils to do as well in arithmetic as they do in reading. (To determine this accurately more than 9 cases are necessary.) On the basis of the marks assigned to the two school subjects, the pupils are assigned ranks, 1 indicating the best, 2 next to the best, etc. This is done in columns 3 and 5. The next step is to determine the difference (D) in rank which each pupil assumes in the two tests. This is done in column 6; for example, Pupil A was first in the arithmetic test and first in the reading test; hence the difference (D) in rank is zero; Pupil B was

second in the arithmetic test and fifth in the reading test; hence the D is 3, etc. The next step is to square the D's and obtain the sum of the D's squared; this is done in column 7. We are now ready to apply our formula:

$$\rho = 1 - \frac{6\Sigma D^2}{n(n^2-1)}$$

ρ=the coefficient of correlation, obtained by the method of rank differences.

$$\rho = 1 - \frac{6 \times 20}{9(81-1)} = 1 - \frac{120}{720} = \frac{600}{720} = +0.83$$

$$\rho = +0.83^{a}$$

What does $\rho = +0.83$ mean? As previously stated, the index theoretically varies from $+1.00$ to -1.00; as a matter of actual practice the index is very seldom negative, and, when it is, it is usually not lower than -0.20, which is considered as insignificant. When is a coefficient of correlation significant? A coefficient of 0 means no correlation, a coefficient of 0.25 or less means small correlation and is of little significance, a coefficient lying between 0.25 and 0.50 means a moderate correlation, a coefficient lying between 0.50 and 0.75 means considerable correlation, and a coefficient above 0.75 means very close correlation. The above interpretations of the significance of the coefficient of correlation are only approximately accurate but will suffice for our work, providing the correlation meets the criterion of reliability. A coefficient of correlation is reliable when its size is at least four times as large as its probable error ($P.E.\rho$).

The formula for the $P.E.\rho$ is:

$$P.E._{\rho} = \frac{0.706\,(1-\rho^2)}{\sqrt{n}}$$

[a] Never speak of the relationship as being 83 per cent, but simply state that the coefficient of correlation is $+0.83$; some writers omit the decimal point and say $+83$.

Making the proper substitutions in this formula we have:

$$P.E._{\rho} = \frac{0.706\,(1 - 0.2739)}{\sqrt{9}} = \frac{0.219566}{3} = .073$$

$$P.E._{\rho} = 0.073$$

The coefficient of correlation $+ 0.84$ is more than four times the size of its $P.E._{\rho}$ 0.073; hence it is a reliable coefficient of correlation, and, since it is larger than 0.75, it may be considered as significant and indicating considerable correlation.

Let us obtain the index of relationship existing between the two following arrays:

Pupils	Teachers' Estimate of Intelligence in Terms of Rank	Score on General Intelligence Test	Rank in General Intelligence Test	D	D^2
A....	1	114	1	0	0
B....	2	104	4	2	4
C....	3	102	5	2	4
D....	4	98	7	3	9
E....	5	108	2	3	9
F....	6	100	6	0	0
G....	7	96	8	1	1
H....	8	106	3	5	25
I....	9	95	9.5 *	0.5	0.25
J....	10	95	9.5 *	0.5	0.25
K....	11	70	20	9	81
L....	12	92	11	1	1
M....	13	85	15 *	2	4
N....	14	85	15 *	1	1
O....	15	85	15 *	0	0
P....	16	90	12	4	16
Q....	17	80	18	1	1
R....	18	82	17	1	1
S....	19	88	13	6	36
T....	20	75	19	1	1
$n = 20$					$\Sigma D^2 = 194.50$

* See last paragraph for explanation of these ranks.

$$\rho = 1 - \frac{6 \times 194.5}{20\ (400 - 1)} = 1 - \frac{1167}{7980} = \frac{6813}{7980} = +0.85$$

$$P.E._{\rho} = \frac{0.706 \times 0.2775}{\sqrt{20}} = \frac{0.1959}{4.47} = 0.044$$

Since the coefficient of correlation is + 0.85, it indicates a considerable relationship, and since the coefficient is more than four times its $P.E._{\rho}$, 0.044, it is a reliable coefficient.

Note that pupils I and J both have a score of 95 on the intelligence test; if J had had a score of 94, then the ranks would have been 9 and 10, but since they both had the same score, the arithmetic mean of 9 and 10 is taken, that is, 9.5. Note that pupils M, N, O, have scores of 85, and that the arithmetic mean of the ranks 14, 15, 16, is 15, and this is taken as the rank for each of the three. With this exception the procedure is the same for obtaining the coefficient of correlation for these arrays as for the first arrays described.

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